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Calendar Year 2000 Annual Site Environmental Report Tonopah Test Range Nevada

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Calendar Year 2000 Annual Site Environmental Report Tonopah Test Range, Nevada

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ABSTRACT

Tonopah Test Range (TTR) in Nevada is a government-owned, contractor-operated facility operated by Sandia Corporation, a subsidiary of Lockheed Martin Corporation. The U.S. Department of Energy (DOE) oversees the operations of the TTR through its Kirtland Area Office (KAO), which reports to the Albuquerque Operations Office (AL). Sandia Corporation conducts operations at TTR in support of DOE's Weapons Ordnance Program and has operated the site since 1957. Westinghouse Government Services subcontracts to Sandia Corporation in administering most of the environmental programs at the site. This Annual Site Environmental Report (ASER) summarizes data and the compliance status of the environmental protection and monitoring program at TTR through December 31, 2000. The compliance status of environmental regulations applicable at the site include state and federal regulations governing air emissions, wastewater effluent, waste management, and Environmental Restoration (ER) cleanup activities. Terrestrial surveillance for radiological and non-radiological contaminants is also conducted, as required by DOE, to determine contaminant levels at off-site, perimeter, and on-site locations. Sandia Corporation is responsible only for those environmental program activities related to its operations. The DOE Nevada Operations Office (NVOO) retains responsibility for the cleanup and management of ER TTR sites. Environmental monitoring and surveillance programs are required by DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990) and DOE Order 231.1, *Environment, Safety, and Health Reporting* (DOE 1996a).

Site Environmental Report for Calendar Year 2000
Sandia National Laboratories, Tonopah Test Range, Nevada
Final Approval date: October 2001

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Main Compound at Tonopah Test Range (TTR) Showing the Control Tower that Overlooks the Range Flight Area

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Acronyms and Abbreviations

A

AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
AL	U.S. Department of Energy/Albuquerque Operations Office
AQC	Air Quality Compliance
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
AST	aboveground storage tank

B

BLM	U.S. Bureau of Land Management
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C

CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CADD	Corrective Action Decision Document
CAP	Corrective Action Plan
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CY	calendar year

D

DMR	Discharge Monitoring Report
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/HQ	U.S. Department of Energy/Headquarters
DOI	U.S. Department of Interior
DRI	Desert Research Institute, Water Resource Center, University of Nevada System
DU	depleted uranium

E

EA	Environmental Assessment
EDE	effective dose equivalent
EO	Executive Orders
EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency

Acronyms and Abbreviations *(continued)*

EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Restoration
ERDA	U.S. Energy Research and Development Administration
ES&H	Environment, Safety, and Health
ESA	Endangered Species Act

F

FFCA	Federal Facilities Compliance Act
FFACO	Federal Facilities Agreement and Consent Order
FIDLER	field instrument for the detection of low-energy radiation
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FY	fiscal year

H

HAP	hazardous air pollutants
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I

ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectrum
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J

JTA	Joint Test Assembly
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K

KAO	U.S. Department of Energy/Kirtland Area Office
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L

LDR	Land Disposal Restriction
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M

MDA	minimum detectable activity
MOA	Memorandum of Agreement
MDC	minimum detectable concentrations
MEI	maximally exposed individual
MSDS	Material Safety Data Sheet
MW	mixed waste

N

NA	not applicable or not available
NAEG	Nevada Applied Ecology Group
NAFB	Nellis Air Force Base (Range Complex)
NAFR	Nellis Air Force Range
NEDS	Non Explosive Destruction Site
ND	Not Detected (or below the detection limit)

Acronyms and Abbreviations *(continued)*

NDEP	Nevada Department of Environmental Protection
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NOS	not otherwise specified
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	National Response Center
NTS	Nevada Test Site
NV	Nevada
NVOO	U.S. Department of Energy, Nevada Operations Office

O

O&M	Operations and Maintenance
-----	----------------------------

P

PA	Preliminary Assessment
PCB	polychlorinated biphenyl
PIC	Pressurized Ionization Chamber
PM	particulate matter
PMS	portable monitoring station
PPE	personal protective equipment

Q

QA	quality assurance
----	-------------------

R

RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
ROD	Record of Decision
RQ	Reportable Quantity

S

SAFER	Streamlined Approach for Environmental Restoration
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Office
SPCC	Spill Prevention, Control, and Countermeasures
SVOC	semi-volatile organic compound

Acronyms and Abbreviations *(continued)*

I

TLD	thermoluminescent dosimeter
TPH	total petroleum hydrocarbon
TRPH	total recoverable petroleum hydrocarbon
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal (facility)
TSP	total suspended particulates
TTR	Tonopah Test Range

U

UDP	underground discharge point
USAF	U.S. Air Force
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
UST	underground storage tank
UXO	unexploded ordnance

V

VOC	volatile organic compound
-----	---------------------------

Acronyms and Abbreviations *(continued)*

Units of Measure

°C	Celsius degree	m	meter
cm	centimeter	m ²	square meter
cm ³	cubic centimeter	m ³	cubic meter
°F	Fahrenheit degree	mg/L	milligrams per liter
ft	feet	mi	mile
g	gram	mi ²	square mile
gal	gallon	m/s	meters per second
in.	inch	ppm	parts per million
kg	kilogram	µm	micron
km	kilometer	yr	year
L	liter	yd ³	cubic yard

Radioactivity Measurements

Ci	curie (unit of radioactivity)	rem	roentgen equivalent man (unit of radiation dose)
mrem	millirem (unit of radiation dose)	µg/g	microgram per gram
mrem/yr	millirem per year	µg/m ²	microgram per square meter
mR/yr	milliroentgen per year	µg/m ³	microgram per cubic meter
mSv	millisievert (unit of radiation dose)		
pCi	picocurie		
pCi/g	picocurie per gram		

Chemical Abbreviations

Al	aluminum	Ar	arsenic
Sb	antimony	Be	beryllium
Ba	barium	Cd	cadmium
Cu	copper	Cr	chromium
Co	cobalt	Pb	lead
Fe	iron	Hg	mercury
Mg	magnesium	Ni	nickel
Mn	manganese	Tl	thallium
K	potassium	Ag	silver
Se	selenium	Zn	zinc
V	vanadium	Am-241	americium-241
Pu-241	plutonium-241	NO _x	nitrous oxides
Pu-242	plutonium-242	Pu-238	plutonium-238
Ra-226	radium-226	Pu-239	plutonium-239
Th-232	thorium-232	Pu-240	plutonium-240
H-3	tritium	SO ₂	sulfur dioxide
Cs-137	cesium-137	U	uranium
		U-238	uranium-238
		U _{tot}	uranium, total

Acronyms and Abbreviations *(concluded)*

Approximate Conversion Factors for Selected SI (Metric) Units

Multiply Si (metric) unit	by	To obtain U.S. customary unit
cubic meter (m ³)	35	cubic feet (ft ³)
centimeter (cm)	0.39	inch (in.)
meter (m)	3.3	feet (ft)
kilometer (km)	0.62	mile (mi)
square kilometer (km ²)	0.39	square mile (mi ²)
hectare (ha)	2.5	acre
liter (L)	0.26	gallon (gal)
gram (g)	0.035	ounce (oz)
kilogram (kg)	2.2	pound (lb)
microgram per gram (μg/g)	1	parts per million (ppm)
milligram per liter (mg/L)	1	Parts per million (ppm)
Celsius (°C)	°F = 9/5 °C + 32	Fahrenheit (°F)





Executive Summary

The U. S. Department of Energy (DOE) oversees Sandia Corporation's Tonopah Test Range (TTR) operations through the DOE Kirtland Area Office (KAO), which reports to the Albuquerque Operations Office (AL). This report was prepared in accordance with, and as required, by DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990) and DOE Order 231.1, *Environment, Safety, and Health Reporting* (DOE 1996a). This report summarizes data from environmental protection and monitoring programs at the TTR through December 31, 2000. It also discusses Sandia Corporation's compliance with environmental statutes, regulations, and permits provisions and highlights other significant environmental programs and efforts at TTR. This report is a key component of Sandia Corporation's and the DOE's effort to keep the public informed about environmental conditions throughout the DOE complex.

Sandia Corporation conducts operations at TTR in support of the DOE's Weapons Ordnance Program. Sandia Corporation's activities involve research, development, and testing of weapon components and delivery systems. Many of these activities require a remote test range with a long flight corridor for air drops and rocket launches. Other activities include explosive tests and gun firings.

Environmental Programs

The following environmental programs are in place at TTR:

- Waste management,
- Terrestrial surveillance,
- Water quality monitoring,
- Air quality compliance,
- Environmental Restoration (ER), and
- National Environmental Policy Act (NEPA).

All program activities are performed on a Calendar Year (CY) 2000 basis, unless otherwise noted.

Waste Management

Waste generated at TTR in 2000 included hazardous waste regulated by the Resource Conservation and Recovery Act (RCRA) and non-hazardous industrial and sanitary waste. The following categories of waste were generated and handled by TTR in 2000:

RCRA waste	1,055 kg
Non-hazardous chemical waste	3,152 kg
Radioactive waste	2,790 kg

All hazardous waste was shipped to permitted treatment, storage, and disposal (TSD) facilities. (Sandia Corporation does not handle waste generated by ER activities.)

ER Project

ER activities at TTR are conducted through the DOE Nevada Operations Office (NVOO). ER sites at TTR include areas contaminated from past rocket firings and target tests, abandoned septic systems, solvent contaminated soils at previous underground storage tank (UST) areas,

and disposal areas for ordnance, septic sludge, and depleted uranium (DU).

In 2000, the ER Project generated 12,372 kg of low-level radioactive waste (LLW) from cleanup activities at two Corrective Action Units (CAUs). Most radioactive waste is shipped to the Nevada Test Site (NTS) for disposal. ER cleanup activities also generated a total of 2.614 kg of RCRA regulated hazardous waste. Another 1,488 kg of non-RCRA regulated hazardous waste was generated by the cleanup of sites with hydrocarbon-impacted soils and debris.

Terrestrial Surveillance

Soil samples were collected from 14 off-site, eight perimeter, and 21 on-site locations in 2000. All soil samples were analyzed for non-radiological (stable metals) and radiological constituents. There was no distinguishable statistical difference between on-site and off-site sample results in 2000. Thermoluminescent dosimeter (TLD) results (a measure of ambient gamma radiation) also showed no statistical difference between on-site and off-site locations in 2000.

Water Quality

Wastewater monitoring results confirmed that all permit conditions set by the State of Nevada were met in 2000.

Water quality samples are routinely taken from Production Well 6, which supplies potable water for Sandia Corporation's Main Compound at TTR. The U.S. Environmental Protection Agency (EPA) also performs sampling on Production Well 6 every three years. Water Quality sample results showed that all permit conditions were met in 2000.

Air Quality

Radiological air emissions are regulated by National Emission Standards for Hazardous Air Pollutants (NESHAP). The only radionuclide sources at TTR are the three Clean Slate Sites, which are sources of diffuse radionuclide emissions as a result of the re-suspension of contaminated soils. These sites are currently being addressed by NVOO under the ER Project. Continuous monitoring was conducted from February 22, 1996 to February 25, 1997 at the TTR airport, the area determined to be the site of the maximally exposed individual (MEI) (SNL 1997). The calculated dose was 0.024 millirem/year (mrem/yr), which is approximately 400 times less than the 10 mrem/yr standard set by the U.S. EPA. Based on this value, an annual dose assessment is not required to be calculated for the TTR site.

TTR's Class II Air Quality Permit requires emission reports from non-radionuclide sources. At TTR these sources include generators, paint booths, and various combustion sources. In 2000, the total emissions reported to the State of Nevada were 2.92 standard tons.

NEPA Activities

At TTR, NEPA compliance is a joint effort between Sandia Corporation and DOE/KAO. Compliance is also supported with the assistance of the Desert Research Institute (DRI), a branch of the University of Nevada System. A total of three NEPA Checklists were submitted to DOE/KAO for proposed actions in 2000.



Chapter 1

Introduction

Sandia Corporation's Tonopah Test Range (TTR) is located on 336,665 acres within the boundaries of the Nellis Air Force Range (NAFR) withdrawal and is used to support activities related to the missions of the U.S. Department of Energy (DOE) and the United States Air Force (USAF). TTR is operated by Sandia Corporation, a subsidiary of Lockheed Martin Corporation (through its contract with the DOE), which is administered by the DOE Kirtland Area Office (KAO), which reports to the DOE Albuquerque Operations Office (AL). As the operations and maintenance contractor for TTR, Westinghouse Government Service performs most all environmental program functions, including environmental media sampling, wastewater effluent and drinking water monitoring, spill response, and waste management operations. Westinghouse Government Service also supports TTR during tests by operating optics equipment, recovering test objects, and performing radiography.

This Annual Site Environmental Report (ASER) is prepared in accordance with, and as required by DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990) and DOE Order 231.1, *Environment, Safety, and Health Reporting* (DOE 1996a). The ASER summarizes data from environmental protection and monitoring programs at TTR through December 31, 2000. The status of environmental programs summarized in this ASER include waste management programs, air, water, terrestrial monitoring and surveillance programs, the Environmental Restoration (ER)

Project, and the National Environmental Policy Act (NEPA) Program. DOE Order 5400.1 specifies the requirements for environmental monitoring conducted at and around the TTR site. The ASER represents an important component of the DOE's and Sandia Corporation's effort to keep the public informed about environmental conditions at DOE facilities.

1.1 TTR HISTORY AND OPERATIONS

In 1940, President Roosevelt established the "Las Vegas Bombing and Gunnery Range" (now referred to as NAFR), which is part of the Nellis Air Force Base (NAFB) Complex. The NAFB Complex, located eight miles north of Las Vegas, Nevada, includes several auxiliary small arm ranges, and the NAFR—divided into a North Range and a South Range (Figure 1-1). The Nevada Test Site (NTS) is located between these two ranges. The entire NAFB Complex is comprised of approximately three million acres. The TTR is located 32 miles southeast of Tonopah, Nevada.

TTR Site Characteristics

The topography at TTR is characterized by a broad, flat, valley bordered by two north and south trending mountain ranges: the Cactus Range to the west (occurring mostly within the boundaries of TTR) and the Kawich Range to the east. Cactus Flat is the valley floor where the main operational area of TTR is located. An area of low hills outcrops in the south. Elevations within TTR range from 1,630 m

1-2 2000 ANNUAL SITE ENVIRONMENTAL REPORT, TONOPAH TEST RANGE

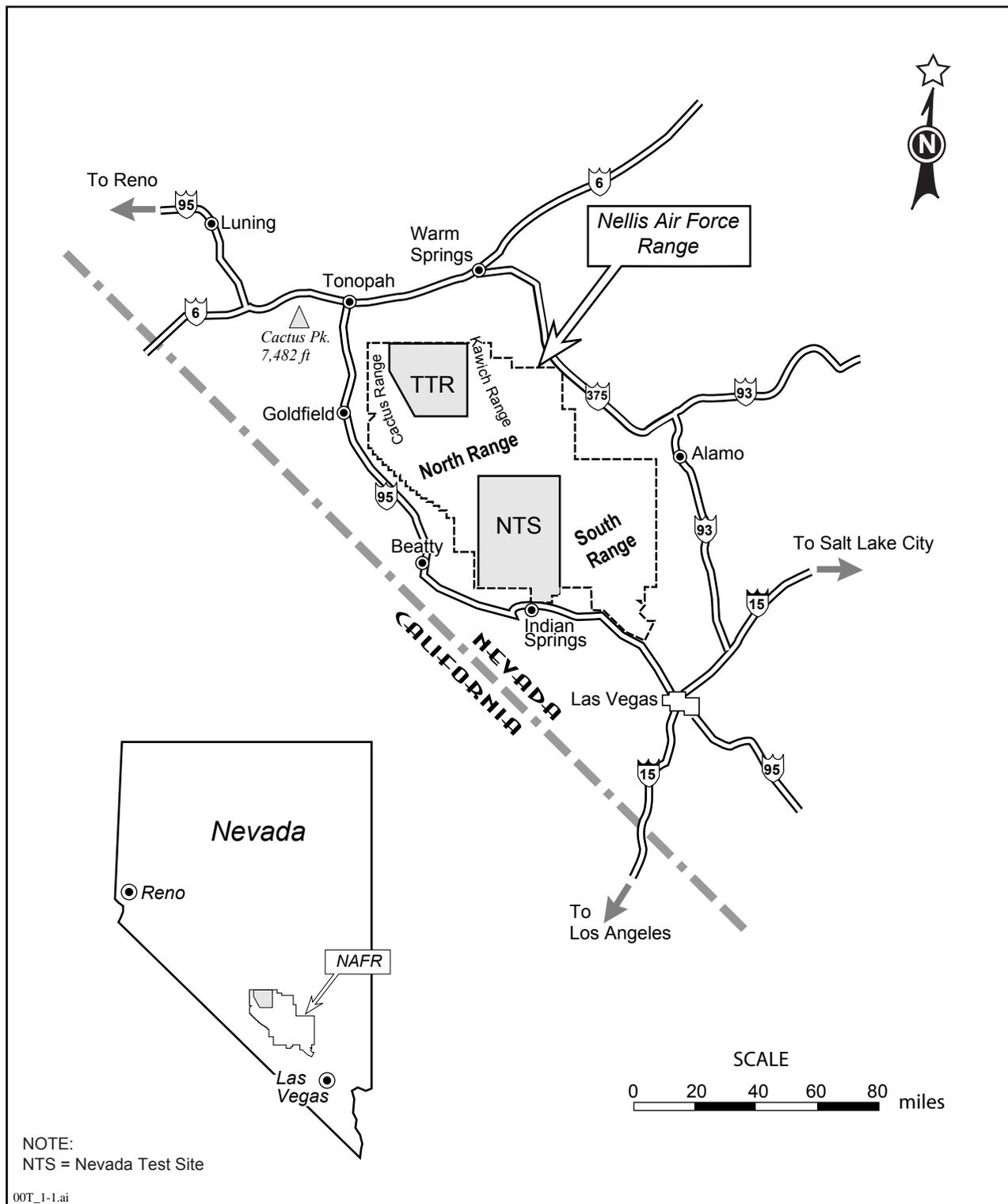


FIGURE 1-1. Location of the Tonopah Test Range (TTR), Within the Boundaries of the Nellis Air Force Range (NAFR), Nevada

(5,347 ft) at the valley floor to 2,279 m (7,482 ft) at Cactus Peak. The elevation within the town of Tonopah is at 1,837 m (6,030 ft).

TTR Site Selection

The TTR was eventually selected as a bombing range after similar facilities at the Salton Sea Test Base in California, as well as Yucca Flat on the NTS, became inadequate. By the mid-1950s, the atmosphere at the Salton Sea Test Base became permeated with haze, which limited visibility and hampered photography. Nevada's Yucca Flat site also became inadequate due to the increasing emphasis on low-altitude approaches and deliveries that required flat terrain and a long approach corridor. The TTR site was located in the northwest corner of the then Las Vegas Bombing and Gunnery Range. The site, which was approximately seven times the size of the Salton Sea Test Base, was well suited because it had immense areas of flat terrain needed for the increasing use of rockets and low-altitude, high-speed aircraft operations. The area was withdrawn in 1956 and TTR became operational in 1957 to operate and test new weapon systems. In the years following World War II, facilities that were built at TTR were originally designed and equipped to gather data on aircraft delivered inert test vehicles under U.S. Atomic Energy Commission (AEC) cognizance (now DOE). Over the years, the facilities and capabilities at TTR were expanded to accommodate tests related to the DOE's Weapons Ordnance Program.

Operations Control Center

The Main Compound in Area 3 is the heart of the test range activities. The Operations Control Center controls and coordinates all test functions and affords a 360-degree view of the site. During test operations, the test director, range safety officer, test project engineer, camera controller, and range communicator operate the consoles in the Operations Control Center to control and coordinate all test functions.

Another important location at the range is Area 9, which has weapons storage facilities and is used to conduct ground-to-air rocket launching tests.

TTR Activities

Principal DOE activities at TTR include: stockpile reliability testing; research and development testing support of structural development; arming, fusing and firing systems testing; and testing nuclear weapon delivery systems. However, no nuclear devices are tested at TTR. TTR is instrumented with a wide array of signal tracking equipment including video, high-speed cameras, radar tracking devices used to characterize ballistics, aerodynamics, and parachute performance on artillery shells, bomb drops, missiles, and rockets.

In recent years, specific test activities at TTR have consisted of the following:

- Air drops (trajectory studies of simulated weapons);
- Gun firings;
- Ground-launched rockets (study of aeroballistics and material properties);
- Air-launched rockets (deployed from aircraft);
- Explosive testing (e.g., shipping and storage containers);
- Static rocket tests (related to the Trident Submarine Program); and
- Ground penetrator tests.

These activities require a remote range for both public safety and to maintain national security. The majority of test activities at TTR occur

within Cactus Flat, a valley with almost no topographical relief flanked by mountains and hills.

Site Responsibility

On October 1, 1997, a Memorandum of Agreement (MOA) was signed between the DOE/AL and the DOE Nevada Operations Office (NVOO) in regards to operational test activities at TTR (DOE 1994). It was determined that DOE/KAO would be responsible for the oversight of TTR; however, NVOO will continue with the oversight of ER activities at TTR. Environmental program management, as discussed in this ASER, is a joint effort between Sandia Corporation employees and contractors at TTR and personnel from Sandia Corporation, New Mexico with oversight from DOE/KAO.

1.2 SITE DESCRIPTION AND DEMOGRAPHICS

TTR is sited within the NAFR at the northern boundary. The area north of the TTR boundary is sparsely populated public lands administered by both the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). The land is currently used to graze cattle. To the east of TTR, and within the NAFR, is the Nevada Wild Horse Range, which is also administered by the BLM.

The nearest residents are located in the town of Goldfield (population 659), approximately 35.4 km (22 mi) west of the site boundary. The town of Tonopah (population 4,400) is the next largest population center, approximately 48.2 km (30 mi) northwest of the site (DOC 2001). Las Vegas, Nevada is 225 km (140 mi) from TTR. The total population within an 80-km (50-mi) radius around TTR is approximately 7,000, which includes the potential population at TTR if all housing units at the site were occupied.

1.3 REGIONAL GEOLOGY, HYDROLOGY, CLIMATE, AND FAUNA

Geology

The regional area around TTR is located in the western part of the Basin and Range geophysical province. This area is marked by horst and graben topography, a system of mountains and down-dropped fault valleys formed through regional extension. TTR lies northeast of the Walker Lane, a zone of transcurrent faulting and shear, and the Las Vegas Valley shear zone to the southeast (Sinnock 1982).

The Cactus Range to the west of TTR is the remnants of a major volcanic center consisting of relatively young (six million-year-old) folded and faulted tertiary volcanics. This range is one of at least five northwest trending, raised structural blocks that lie along the Las Vegas Valley-Walker Lane lineaments (ERDA 1975).

Surface Water

Drainage patterns within and near TTR are intermittent (ephemeral stream channels) and end in closed basins. Ephemeral streams occasionally carry spring runoff to the center of Cactus Flat where there is a string of north-south trending dry lake beds; however, due to the high rate of evaporation, little is recharged to the groundwater (DRI 1991).

There are several small springs within the Cactus and Kawich Ranges. Three springs occur within TTR boundaries: Cactus, Antelope, and Silverbow Springs. Water from these springs does not travel more than several tens of meters dissipating rapidly through evaporation and infiltration. The effect on the landscape is purely local.

Groundwater

TTR derives its water from local wells. The U.S. Geological Survey (USGS) has recorded groundwater depths from 21 to 454 ft at the site. Groundwater is encountered at the Antelope

Mine well in the Cactus Range at 21 ft and at the EH2 well near the TTR Airport at 454 ft. The depth to groundwater at the Area 9 well located at the north end of the site is approximately 131 ft. South of the Area 9 well, groundwater is encountered at 361 to 394 ft in Area 3. The static water level at the main water supply well (Well 6) is approximately 350 ft.

Climate

The climate at TTR is mild and usually dry, but, as is typical of high deserts, is subject to large diurnal and seasonal changes in temperature—from a record high of 38.8 °C (102 °F) to a record low of -4 °C (24 °F) (Schaeffer 1970). July and August are hottest with temperatures ranging from the 90s during the day and dropping to the 50s at night. Clear, sunny days with light to moderate winds are usual.

Rainfall is dependent on elevation. The annual average rainfall at the desert floor is 10 cm (4 in.) and 30.4 cm (12 in.) in the mountains. The primary rainfall season is in the summer with a lesser rainy season in the winter (USAF 1978).

Winds are mostly from the northwest from late fall to spring, and are influenced by the Pacific air flow patterns coming over the Sierra Nevada Mountains in California. From summer through early fall, the winds generally shift to a southeasterly direction blowing in from the Gulf of Mexico. Dust storms are common in the spring and dust devils occur in the summer.

Vegetation

Temperature extremes and arid conditions of the high desert limit vegetation coverage. Sparse vegetation occurring in Cactus Flat is predominantly range grasses and low shrubs typical of the Great Basin Desert flora (ERDA 1975; EG&G 1979a).

Vegetation is divided into two basic types at the site by elevation—salt desert shrub in the low areas and northern desert shrub in the higher

elevations (USAF 1978, DRI 1991). Salt desert shrub is characteristic of poorly drained soils and is common along dry lakebeds. Specific plants in this group include shadscale (a type of salt bush) (*Atriplex confertifolia*), Russian thistle (*Salsola kali*), and sagebrush (*Artemisia tridentata*). Northern desert shrub, found in the Cactus Range, includes a variety of sagebrush, rabbitbrush (*Chrysothamnus nauseosus*), squirrel tail (*Elymus longifolius*), juniper (*Juniperus* varieties), and Nevada bluegrass (*Poa nevadensis*). Joshua trees (*Yucca brevifolia*) and juniper grow in the transition zone at the base of the mountains.

Wildlife

The Nevada Wild Horse Range and other wild horse land-use areas compose a significant portion of the North Range with herds common in Cactus and Gold Flats, Kawich Valley, Goldfield Hills, and the Stonewall Mountains. Hundreds of wild horses (*Equus caballus*) graze freely throughout TTR and activities onsite have had apparently little affect on the horse population or their grazing habits. The BLM routinely rounds up a portion of the herds for dispersal through the Horse Adoption Program.

Other mammals common to the area include pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), kit fox (*Vulpes macrotis*), bobcat (*Zynx rufus*), coyote (*Canis latrans*), and gray fox (*Urocyon cinereoargenteus*). To a lesser extent, bighorn sheep (*Ovis canadensis*), mountain lion (*Felis concolor*), and burros (*Equus asinus*) are also present (USAF 1978, DRI 1991). Common birds include various raptor species.

In general, the NAFR land withdrawal has provided a positive effect on local plant and animal life. Since much of the withdrawn area is undisturbed by human activity, large habitat areas are protected from the affects of public use. For example, recreational off-road vehicles can cause significant impacts to desert flora and fauna and it can take years for fragile desert ecosystems to recover from disturbances.

1.4 CLEAN SLATE AND DOUBLE TRACKS SITES

In May and June 1963, Project Roller Coaster included a series of four nuclear weapons destruction tests that resulted in plutonium dispersal in the surrounding soils. Three of these tests were conducted within the boundaries of TTR; the fourth was conducted on the NAFR just west of TTR. The three Project Roller Coaster test sites at TTR are referred to as Clean Slates 1, 2, and 3 (Figure 1-2). The fourth test site at NAFR is referred to as Double Tracks. In 1996, the Double Tracks was closed after remediation of soil contamination was reduced to a level of less than or equal to 200 pCi/g of transuranics.

Table 1-1 summarizes test information related to the four Project Roller Coaster sites. NVOO has responsibility for the remediation of these and all

other ER sites at TTR. Sandia Corporation will continue to be responsible for environmental compliance at these sites (e.g., air monitoring).

The initial cleanup of each Clean Slate site was conducted shortly after each test. Test-related debris was bladed into a hole at test ground zero and backfilled. An initial fence was built around each test area where the soil contamination was set at approximately $1,000 \mu\text{g}/\text{m}^2$ of plutonium. The soil survey was conducted on 61-m grids with a hand-held survey meter or field instrument for the detection of low-energy radiation (FIDLER). In 1973, additional outer fences were set at 40 pCi/g of plutonium in soil also using the hand-held meter method. Soil sampling is conducted periodically at these sites and the areas are visually inspected twice a year to determine whether any fence repairs are required. Any horses that may wander inside the fenced areas are promptly removed.

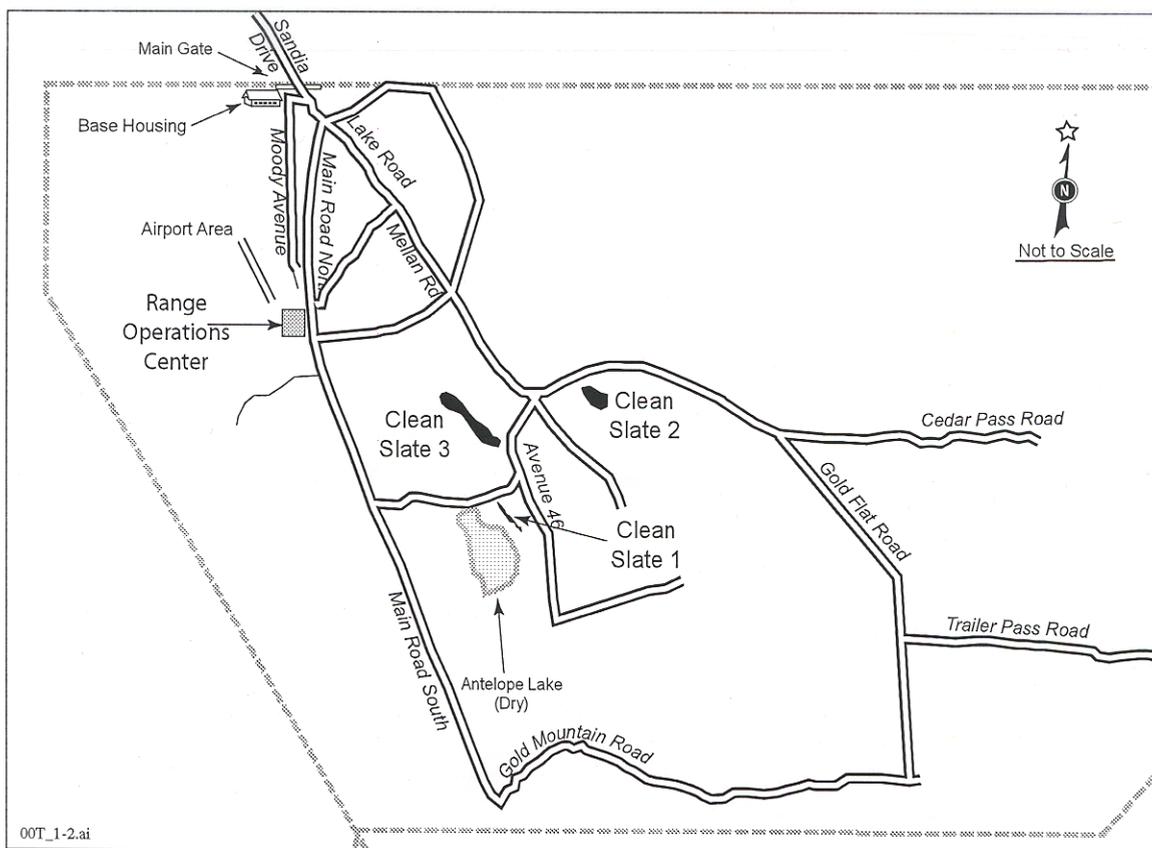


FIGURE 1-2. Location of Facilities Operated by Sandia Corporation, Nevada at TTR

In 1977, an aerial radiological survey was performed by EG&G, Inc. for the Nevada Applied Ecology Group (NAEG) (EG&G 1995). The aerial radiological surveys were undertaken to supplement the FIDLER and previous soil sample measurements of transuranics. The objective was to determine the extent of surficial distribution of plutonium and other transuranic elements dispersed during the Project Roller Coaster tests. Radiation isopleths showing soil activity due to americium-241 (Am-241), plutonium-239 (Pu-239), and plutonium-240 (Pu-240) were drawn for each area. The cumulative area of the diffuse sources, as determined by the aerial radiological survey, is 20 million m². The results of the survey found transuranic

contamination outside the fenced area in the downwind direction (EG&G 1995).

Air Monitoring at ER sites

Remediation activities were conducted at Clean Slate 1 in 1997. The Desert Research Institute (DRI) collected air monitoring data from several locations in the vicinity of Clean Slate 1 before, during, and after remediation activities. Although these data have been validated, they have only as of yet been presented to NVOO in draft reports. A final report is pending. Bechtel Nevada has two air monitoring stations available for use at TTR. NVOO put a halt on air monitoring in April 2000 and will not resume until active remediation efforts at the Clean Slate sites begin again.

TABLE 1-1. Project Roller Coaster Test Information

Test Name	Date of Test	Location	Status
Clean Slate 1	May 25, 1963	TTR	Remediation completed in 1997
Clean Slate 2	May 31, 1963	TTR	Remediation on hold
Clean Slate 3	June 9, 1963	TTR	Remediation pending
Double Tracks	May 15, 1963	NAFR, North Range (west of TTR)	Remediation completed in 1996

NOTE: TTR = Tonopah Test Range

NAFR = Nellis Air Force Range

Source: Sampling And Analysis Plan For Clean Slate 1, September 1996 (IT 1996)

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Chapter 2

Compliance Summary

Sandia Corporation is responsible for Environment, Safety, and Health (ES&H) compliance activities performed at the Tonopah Test Range (TTR). This chapter discusses the status of ES&H compliance with federal environmental statutes, regulations, Executive Orders (EOs), and the U.S. Department of Energy (DOE) Orders. Environmental audit summaries, occurrence reporting, and environmental permit status for 2000 are presented at the end of this chapter.

Sandia Corporation and DOE strive to meet 100 percent compliance with environmental laws, regulations, and other requirements established by federal and state agencies. The State of Nevada administers most environmental regulations applicable to TTR. Specific state regulations listed in Appendix A include regulations governing solid and hazardous waste management, wildlife, wastewater effluent, and radiation control. Radionuclide air emissions regulations are administered directly by the U.S. Environmental Protection Agency (EPA).

Sandia Corporation, Nevada works in close cooperation with Sandia Corporation to carry out environmental program activities at TTR. Sandia Corporation, Nevada and Sandia Corporation, New Mexico are responsible for environmental compliance at TTR. Westinghouse Government Services contracts to Sandia Corporation and performs or assists with most environmental program activities, such as air monitoring, water sampling, and waste characterization. Major federal laws applicable to environmental compliance at TTR are presented on page 2-2 (see shaded box).

2.1

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA)

CERCLA defines assessment activities and reporting requirements for inactive waste sites at federal facilities. As required by CERCLA, a Preliminary Assessment (PA) was submitted in 1988 for all facilities listed on the federal agency hazardous waste compliance docket. Sites with significant contamination were put on the National Priorities List (NPL), an ordered ranking of cleanup priority. There are no NPL or "Superfund" sites located at TTR.

Additional CERCLA requirements are given in the Superfund Amendments and Reauthorization Act (SARA) Title III for reportable quantity (RQ) releases and chemical inventory reporting. Sandia Corporation was in full compliance with CERCLA and SARA in 2000.

Emergency Planning and Community Right-to-Know Act (EPCRA)

SARA Title III (also known as EPCRA) requires the submittal of a Toxic Release Inventory (TRI) report for chemical releases over a given threshold quantity. In 2000, Sandia Corporation was not required to submit a TRI report since its chemical use on-site was below the reporting threshold. The State of Nevada also requires reporting for the use of extremely hazardous substances (EHSs); however, no EHSs were used at TTR in 2000. Table 2-1 summarizes Sandia Corporation's compliance with SARA Title III reporting requirements.

Major Environmental Regulations & Statutes Applicable to Sandia at TTR	
✓ Clean Air Act (CAA) and CAA Amendments (CAAA)	<i>Provides standards to protect the nation's air quality</i>
✓ Clean Water Act (CWA)	<i>Provides general water quality standards to protect the nation's water sources and byways</i>
✓ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	<i>Provides federal funding for cleanup of inactive waste sites on the NPL and mandates requirements for reportable releases of hazardous substances</i>
✓ Cultural resources acts	<i>Includes various acts that protect archeological, historical, and religious sites and resources</i>
✓ Endangered Species Act (ESA)	<i>Provides special protection status for federally-listed endangered and threatened species</i>
✓ Executive Orders (EOs) 11988 and 11990	<i>Two EOs provide specific protection for wetlands and floodplains</i>
✓ Federal Facilities Compliance Act (FFCA)	<i>Directs federal agencies in the management of mixed waste</i>
✓ Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<i>Controls the distribution and use of various pesticides</i>
✓ National Emission Standards for Hazardous Air Pollutants (NESHAP)	<i>Specifies standards for radionuclide air emissions and other hazardous air releases</i>
✓ National Environmental Policy Act (NEPA)	<i>Ensures that federal agencies review all of their proposed activities that have the potential to affect the environment. NEPA provides an opportunity for public involvement for projects' potential significant impacts</i>
✓ Resource, Conservation, and Recovery Act (RCRA)	<i>Mandates the management of listed hazardous waste and materials</i>
✓ Safe Drinking Water Act (SDWA)	<i>Provides specific standards for drinking water sources</i>
✓ Superfund Amendments and Reauthorization Act (SARA)	<i>SARA, Title III (known as the EPCRA), mandates communication standards for hazardous materials over a threshold amount that are stored or used in a community</i>
✓ Toxic Substance Control Act (TSCA)	<i>Specifies rules for the manufacture, distribution, and disposal of specific toxic materials such as asbestos and polychlorinated biphenyls (PCBs)</i>

TABLE 2-1. Reporting Activities for TTR in 2000 with Respect to SARA Title III Compliance

SARA, Title III (EPCRA)	Regulation Section Description	SNL Reporting			Explanation
		Yes	No	Not Required	
302 - 303	Notification/Plans	✓			This report was submitted to notify state and local emergency response authorities and to carry out other facility notification responsibilities.
304	Emergency Notification			✓	There were no reportable quantity releases of a EHS as defined under CERCLA. No EHS is used in routine operations at TTR.
311-312	MSDS/Chemical Inventory	✓			MSDS information is made available to local emergency organizations.
313	Toxic Chemical Release Forms			✓	Sandia Corporation was below the Toxic Release Inventory (TRI) reporting threshold for any listed chemical.

NOTE: MSDS = Material Safety Data Sheet
 EHS = Extremely Hazardous Substance
 TTR = Tonopah Test Range

2.2 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

Under the RCRA Hazardous Waste Permit Program (40 CFR 270), TTR is permitted as a “small quantity generator.” Under this designation, hazardous waste cannot be stored on-site for over 180 days before it must be shipped off-site for treatment and disposal at an EPA-permitted facility. At TTR, hazardous waste shipments are scheduled to occur at least two to three times a year. In 2000, a total of 1,055 kg of RCRA waste was generated by Sandia Corporation activities. An additional 3,152 kg of Non-RCRA waste was disposed of through the waste contractor. Recyclable waste totaling 2,790 kg, including used oil, was sent for recycling or disposed of through the waste disposal contractor. (Environmental Restoration (ER) Project waste is not included in these totals.)

Sanitary solid waste, which is also regulated under RCRA, is disposed of at landfills on-site. There is one Class II sanitary landfill in operation

at TTR operated by the U.S. Air Force (USAF) Operations and Maintenance (O&M) contractor. The landfill is used cooperatively by all organizations at TTR.

Underground Storage Tanks (USTs) – RCRA, Subtitle I (40 CFR 280) sets forth requirements for USTs that contain hazardous materials or petroleum products. There are no USTs requiring registration at TTR. The last five USTs (two diesel tanks and two gasoline tanks were removed from Area 3 at the site of a former gas station and one diesel tank was removed from Area 9 that had supplied generator fuel) were removed in August 1995.

2.3 FEDERAL FACILITIES COMPLIANCE ACT (FFCA)

The FFCA amendments to RCRA specifically address Land Disposal Restriction (LDR) requirements for the treatment of mixed waste (MW) at federal facilities. Since TTR does not generate MW and currently has no MW stored

on-site, this statute is not applicable to Sandia Corporation's operations at TTR.

2.4

CLEAN AIR ACT (CAA) AND CLEAN AIR ACT AMENDMENTS (CAAA) OF 1990

CAA and CAAA of 1990 requirements are regulated by the State of Nevada air quality regulations. Air Emissions from non-radionuclide sources, such as generators and other combustion sources, are permitted under a Class II Air Quality Permit. Sandia Corporation tracks emissions and pays a fee to the State of Nevada based on the total standard tons emitted. Sandia Corporation met all air quality permit conditions in 2000.

NESHAP Compliance

The EPA retains compliance authority for all radionuclide air releases, which are regulated by NESHAP and implemented under 40 CFR 61, Subpart H.

The Clean Slate sites, as discussed in Chapter 1, have been the only source of radionuclide air emissions at TTR. Continuous air monitoring was conducted from February 22, 1996 to February 25, 1997 (SNL 1997). The TTR Airport was determined to be the location of the maximally exposed individual (MEI). The result of 0.024 mrem/yr was below the threshold of 0.1 mrem/yr for which continuous air monitoring would be required and approximately 400 times less than the EPA standard of 10 mrem/yr. The 2000 Annual NESHAP Report and Chapter 5 of this report discuss these monitoring results (SNL 2001a).

2.5 CLEAN WATER ACT (CWA)

Wastewater effluents and potable water supplies are regulated under the CWA and State of Nevada water pollution and sanitary waste systems regulations. The State of Nevada, Bureau of Health Protection Services and the Nevada Department of Environmental Protection (NDEP) administer regulations relevant to wastewater discharges. At TTR, wastewater is discharged to the sewer system connected to the USAF sewage lagoon and to six septic tank systems.

There were no excursions or other permit violations in 2000 with respect to wastewater discharges.

Storm Water

The issuance of a National Pollutant Discharge Elimination System (NPDES) storm water permit is generally based on whether or not storm water runoff is discharged to "Waters of the U.S." This definition includes rivers, lakes, streams, and swamps, as well as channels and arroyos that lead to waters that are currently used, have been used in the past, or may be susceptible for use in interstate or foreign commerce. The TTR site is primarily a closed basin with runoff evaporating or infiltrating to the ground. The USAF has permitted its airfield and Area 10 for storm water runoff and have cognizance over all storm water issues at the site. Currently, Sandia Corporation does not conduct any activities at TTR that require storm water permitting or monitoring.

2.6 SAFE DRINKING WATER ACT (SDWA)

Sandia Corporation meets standards for drinking water as defined in the SDWA and State of Nevada public water supply and public water systems regulations. Well 6 provides all

drinking water for Sandia Corporation's operations at TTR and is operated under a permit issued by the State of Nevada. Sandia Corporation remained in compliance with all Well 6 permit requirements in 2000.

2.7 TOXIC SUBSTANCES CONTROL ACT (TSCA)

Compliance with the TSCA at TTR primarily concerns the management of asbestos and polychlorinated biphenyls (PCBs). As defined by the TSCA, any material with greater than or equal to 500 parts per million (ppm) is considered "PCB"; materials with greater than or equal to 50 ppm, but less than 500 ppm are considered "PCB-contaminated." In 1993, sampling was performed on TTR transformers to determine if PCBs were present in the oil (IT 1993). All samples contained less than 50 ppm of PCBs.

2.8 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

Chemical pesticides used at TTR include herbicides, rodenticides, and insecticides, as required. All chemicals used are EPA-approved and applied in accordance with applicable label guidelines and regulations. Sandia Corporation retains records of the quantities and types of pesticides that are used as well as Material Safety Data Sheets (MSDSs) for each pesticide. There were no violations of the FIFRA in 2000.

2.9 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

NEPA applies to federal government agencies and any private entities that are performing federally-sponsored projects. NEPA requires federal agencies, such as the DOE, to analyze the potential impacts to the environment from their proposed actions. If the proposed action is potentially "significant," the agency would be required to prepare an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) before the project is allowed to begin. Although a major intention of NEPA is to preserve the environment for future generations, NEPA does not mandate environmental protection per se. NEPA only ensures that federal agencies make informed decisions and are aware of the environmental impacts of their actions before proceeding. NEPA does mandate that the decision process be open for public review.

Activities at TTR conducted by Sandia Corporation are included in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE 1996b). Sandia Corporation provides technical guidance for all NEPA issues at TTR. Sandia Corporation's NEPA Program is under the direction of the DOE Kirtland Area Office (KAO).

2000 NEPA Documentation

During 2000, Sandia Corporation submitted three NEPA Checklists to DOE/KAO for proposed projects at TTR that were determined to be within the Nevada Test Site (NTS) EIS envelop.

2.10 ENDANGERED SPECIES ACT (ESA)

The ESA applies to both private individuals and federal agencies. Federal agencies must ensure that any action authorized, funded, or carried out by them will not jeopardize the continued existence of a threatened or endangered species, or result in adverse modifications of its habitat. The ESA is addressed under the NEPA Program. If potentially significant impacts to sensitive species or habitats are found as a result of the proposed action, an EA or an EIS must be prepared.

The EIS for the NTS, which includes activities at TTR, discusses biological resources present at the site (DOE 1996b). As of 1996, no federal threatened, endangered, or candidate plant or animal species were known to occur at TTR. Bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*), however, may be rare migrants at the site. The western burrowing owl (*Athene cunicularia hypugaea*), a state-protected species, is known to occur on TTR. Table 2-2 lists all endangered, threatened, and sensitive species occurring within Nye County, therefore having the potential to occur at TTR. Operations at TTR are not known to have impacted any threatened or endangered species, or resulted in adverse modifications to its habitat.

2.11 CULTURAL RESOURCES ACTS

Federal cultural resources management responsibilities are applicable to activities at TTR. These include but are not limited to compliance with the following laws and their associated regulations:

- National Historic Preservation Act (NHPA)
- Archaeological Resources Protection Act (ARPA)
- American Indian Religious Freedom Act (AIRFA)

DOE/KAO has responsibility for determining the level of applicability of cultural resources requirements. Sandia Corporation operations did not impact any known cultural resources sites at TTR in 2000.

2.12 EXECUTIVE ORDERS (EOs)

EO 11988, *Floodplain Management*, and EO 11990, *Protection of Wetlands*, require evaluation of the potential effects of actions taken in these environmentally sensitive areas. However, there are no floodplains or significant wetlands at TTR. There are, however, some very limited wetlands in the vicinity of several springs. These provide an important source of drinking water for wildlife in the area. Sandia Corporation complies with all applicable mandates stated in the EOs.

2.13 2000 AUDITS

Table 2-3 lists audits and inspections conducted by various agencies in 2000, including assessments made by Sandia Corporation. Only minor observations were noted in all cases. There were no audits conducted by the State of Nevada in 2000. The DOE Nevada Operations Office (NVOO) conducted an audit on the radioactive waste program in July 2000.

TABLE 2-2. Protected Species Potentially Occurring in Nye County, Nevada

Common Name	Scientific Name	Federal Status	State of Nevada Status
PLANTS			
Beatley milkvetch	<i>Astragalus beatleyae</i>	--	State Protected
Sodaville milkvetch	<i>Astragalus lentiginosus var. sesquimetalis</i>	--	State Protected
Halfring milkvetch	<i>Astragalus mohavensis var hemigyus</i>	--	State Protected
Milkvetch	<i>Astragalus phoenix</i>	Threatened	State Protected
Spring-loving centaury	<i>Centaureum namophilum</i>	Threatened	State Protected
Ash Meadows sunray	<i>Enceliopsis nudicaulis var. corrugata</i>	Threatened	State Protected
Sunnyside green gentian	<i>Frasera gypsicola</i>	--	State Protected
Ash Meadows gumplant	<i>Grindelia fraxinopratensis</i>	Threatened	State Protected
Ash Meadows ivesia	<i>Ivesia kingii var. eremica</i>	Threatened	State Protected
Ash Meadows blazingstar	<i>Mentzelia leucophylla</i>	Threatened	State Protected
Amargosa niterwort	<i>Nitrophila mohavensis</i>	Endangered	State Protected
Sand cholla	<i>Opuntia pulchella</i>	--	State Protected
Williams combleaf	<i>Polycytenium williamsiae</i>	--	State Protected
Tonopah fishhook cactus	<i>Sclerocactus nyensis</i>	--	State Protected
Blaine Pincushion	<i>Sclerocactus blainei</i>	--	State Protected
INSECTS			
Ash Meadows naucorid	<i>Ambrysus amargosus</i>	Threatened	
FISH			
White River desert sucker	<i>Catostomus clarki intermedius</i>	--	State Protected
Moorman White River springfish	<i>Crenichthys baileyi thermophilus</i>	--	State Protected
Railroad Valley springfish	<i>Crenichthys nevadae</i>	Threatened	State Protected
Devils Hole pupfish	<i>Cyprinodon diabolis</i>	Endangered	State Protected
Ash Meadows Amargosa pupfish	<i>Cyprinodon nevadensis mionectes</i>	Endangered	State Protected
Warm Springs Amargosa pupfish	<i>Cyprinodon nevadensis pectoralis</i>	Endangered	State Protected
Pahrump poolfish	<i>Empetrichthys latos latos</i>	Endangered	State Protected
Big Smoky Valley tui chub	<i>Gila bicolor ssp.</i>	--	State Protected
Hot Creek Valley tui chub	<i>Gila bicolor ssp.</i>	--	State Protected
Little Fish Lake Valley tui chub	<i>Gila bicolor ssp.</i>	--	State Protected
Railroad Valley tui chub	<i>Gila bicolor ssp.</i>	--	State Protected
White River spinedace	<i>Lepidomeda albivallis</i>	Endangered	State Protected
Moapa dace	<i>Moapa coriacea</i>	Endangered	State Protected
Lahontan cutthroat trout	<i>Oncorhynchus clarki henshawi</i>	Threatened	State Protected
Big Smoky Valley speckled dace	<i>Rhinichthys osculus lariversi</i>	--	State Protected
Nevada speckled dace	<i>Rhinichthys osculus nevadensis</i>	Endangered	State Protected
REPTILES & AMPHIBIANS			
Banded gila monster	<i>Heloderma suspectum cinctum</i>	--	State Protected
Amargosa toad	<i>Bufo nelsoni</i>	--	State Protected
BIRDS			
Northern goshawk	<i>Accipiter gentilis</i>	--	State Protected
Western burrowing owl	<i>Athene cunicularia hypugaea</i>	--	State Protected
Ferruginous hawk	<i>Buteo regalis</i>	--	State Protected
Swainson's hawk	<i>Buteo swainsoni</i>	--	State Protected
Sage grouse	<i>Centrocercus urophasianus</i>	--	State Protected
Western snowy plover	<i>Charadrius alexandrinus nivosus</i>	--	State Protected
Black tern	<i>Chlidonias niger</i>	--	State Protected
Western least bittern	<i>Ixobrychus exilis hesperis</i>	--	State Protected
Flammulated owl	<i>Otus flammeolus</i>	--	State Protected

TABLE 2-2. Protected Species Potentially Occurring in Nye County, Nevada (*concluded*)

Common Name	Scientific Name	Federal Status	State of Nevada Status
BIRDS (<i>concluded</i>)			
Phainopepla	<i>Phainopepla nitens</i>	--	State Protected
White-faced Ibis	<i>Plegadis chihi</i>	--	State Protected
Yuma clapper rail	<i>Rallus longirostris yumanensis</i>	Endangered	State Protected
MAMMALS			
Spotted bat	<i>Euderma maculatum</i>	--	State Protected

TABLE 2-3. Summary of Environmental Audits Performed at TTR in 2000

Audit Title	Date	Results Summary
ES&H Self-Assessment of Department 15324, Tonopah Test Range (TTR)	December 5, 2000	Several noteworthy comments and numerous minor recommendations were made.
DOE/AL/KAO RCRA Audit	September 26, 2000	Several recommendations.
Electrical Safety Assistance Visit (SNL/NM)	September 26, 2000	Several noteworthy comments.
Annual Spill Prevention, Control, and Countermeasures (SPCC) Inspection (SNL/NM)	May 24, 2000	There were no violations. Several minor recommendations were made.
SNL Internal Environment, Safety, and Health (ES&H) and Quality Appraisal	April 21, 2000	Several recommendations and notable practices.

NOTE: DOE = U.S. Department of Energy
 SNL/NM = Sandia National Laboratories, New Mexico
 AL = Albuquerque Operations Office
 KAO = Kirtland Area Office

2.14 2000 ISSUES AND ACTIONS FOR TTR

Ongoing self-assessments of Sandia Corporation's compliance status continue to identify compliance issues. Resolution of these issues is coordinated with regulatory agencies to ensure that they are adequately addressed. The following sections highlight current issues of concern or interest at TTR.

Federal Facility Agreement and Consent Order (FFACO) Compliance for ER Activities

An ongoing action started in 1996 is the FFACO with the State of Nevada. This agreement was

implemented in May 1996 between the State of Nevada, DOE, and the Department of Defense (DoD) (DoD/DOE 1996). All DOE cleanup activities in the State of Nevada must be conducted in conformance with the requirements of this agreement. The FFACO is an enforceable agreement with stipulated penalties for violations. The ER sites for which DOE has assumed responsibility, and which are subject to the FFACO agreement, include:

- Nevada Test Site (NTS),
- Areas within TTR,
- Areas within Nellis Air Force Range (NAFR),
- Central Nevada Test Area, and

- Project Shoal Area (east of Carson City in Churchill County).

A summary of DOE's ER sites in Nevada can be found in the FFACO report (DoD/DOE 1996). The list of sites has been modified for consistency with NDEP requirements and grouped into Corrective Action Units (CAUs), which are listed by Corrective Action Site (CAS) numbers. Each CAU is listed in the FFACO under Appendices II (inactive CAUs) and III (active CAUs) and are updated every six months. Table 3-1 gives a listing of ER sites located at TTR.

2.15 ENVIRONMENTAL PERMITS

Environmental compliance permits for TTR include those for potable water supply, sewage, and specific air emission units, such as generators. The permit application and registration of Sandia Corporation activities at TTR are issued directly by the State of Nevada to either DOE NVOO or DOE/KAO and administered by Westinghouse. Sandia Corporation and Westinghouse ensure that all permit conditions are adhered to. Table 2-4 lists all permits and registrations in effect in 2000. TTR was in full compliance with all permitting requirements for 2000.

The permit for Well 6 (NY-3014-12NC) is renewed annually by the State of Nevada Bureau of Health Protection Services. Permit updates are obtained annually and copies are forwarded to DOE/KAO and Sandia Corporation.

2.16

OCCURRENCE REPORTING

On May 24, 2000, during an annual inspection, an area of discolored soil was detected beneath a 1,000-gal diesel fuel storage tank used to supply a backup emergency generator. The tank had a slow drip coming from the bottom of its secondary containment drain plug. Contaminated soil was excavated, sampled, and transported to a certified petroleum landfill. Field instrumentation was used during the remediation of the release as an indicator of soil contamination levels. The remediation continued until the field instrumentation indicated levels below reporting limits. Samples were then obtained from the bottom and sides of the excavation and sent to a state certified laboratory for confirmatory analysis. Remediation of the site was completed on May 31, 2000. Confirmatory analysis of samples from the bottom and sides of the excavation indicate the site has been remediated to comply with State of Nevada standards.

TABLE 2-4. Summary of Permit Ownership at TTR

Permit Type and Location	Permit Number	Issue Date	Expiration Date	Comments
Air Quality Permits				
Open Burn Variance (Fire Extinguisher Training)	99-122	January 1, 2000	December 31, 2000	State of Nevada
Class II Air Quality Operation Permit	AP9611-0680	March 1, 1999	June 12, 2001	1 3 x 5 Screening Plant 1 7 x 7 Screening Plant Generators (53 emission units) Boilers (7 emission units) Maintenance Activities (5 emission units) Propane Storage Tanks (23 emission units) Surface Area Disturbance (> 5 acres)
RCRA - Hazardous Waste				
Hazardous Waste Generator	NV1890011991	January 7, 1993	Indefinite	State of Nevada
Production Well (Drinking Water)				
Well 6 Production Well	NY-3014-12NC	September 1999	September 2000	State of Nevada

NOTE: TTR = Tonopah Test Range

RCRA = Resource Conservation and Recovery Act

"Emission units" are sources such as generators and boilers.



Chapter 3

Environmental Programs Information

Environmental programs at Sandia Corporation's Tonopah Test Range (TTR) are in place to meet compliance with state and federal regulations, Executive Orders (EOs), and U.S. Department of Energy (DOE) Orders. Programs and activities discussed in this chapter include the Environmental Restoration (ER) Project, the Waste Management Program, National Environmental Policy Act (NEPA) compliance activities, and environmental monitoring by outside agencies. Terrestrial surveillance, water quality programs, and air quality programs are discussed in the remaining chapters of this report.

Surveillance and Effluent Monitoring Programs

In general, surveillance monitoring is the sampling of ambient environmental media, such as soil, sediment, vegetation, groundwater, and air. Effluent monitoring is the direct sampling of waste streams such as wastewater and air emissions. Effluent and surveillance monitoring activities are discussed in Chapters 4, 5, 6, and 7, respectively. Environmental program areas covered in these chapters are as follows:

- Terrestrial Surveillance Program
- Ambient Air Quality Program
- Air Quality Compliance Program
- National Emission Standards for Hazardous Air Pollutants (NESHAP) Program
- Groundwater Protection Program (GWPP)
- ER Project

3.1 ER PROJECT ACTIVITIES

The ER Project at TTR began in 1980 to address contamination resulting primarily from nuclear weapons testing and related support activities. In late 1992 and early 1993, an agreement was reached between DOE Headquarters (HQ), the DOE Albuquerque Operations Office (AL), and the DOE Nevada Operations Office (NVOO) regarding the management of ER activities at TTR. The decision was made to designate the responsibility of all ER sites to NVOO.

Since 1996, cleanup activities for sites located in the State of Nevada have been regulated by the Federal Facility Agreement and Consent Order (FFACO) (DoD/DOE 1996). The FFACO was negotiated between NVOO, the Nevada Division of Environmental Protection (NDEP), and the U.S. Department of Defense (DoD). The Compliance Order took effect on May 10, 1996 and accomplished the following:

- Established a framework for identifying Corrective Action Sites (CASs),
- Grouped CASs into Corrective Action Units (CAUs),
- Prioritized CAUs, and
- Implemented corrective action activities.

The FFACO is also discussed in Section 2.14. CAUs located at TTR are addressed by two ER Division Projects:

- **Industrial Sites Project** – Past sites used to support nuclear testing activities, and
- **Soil Sites Project** – Areas where tests resulted in extensive surface and/or shallow subsurface contamination.

ER site contamination includes radiological (e.g., depleted uranium [DU] and plutonium) and non-radiological constituents (e.g., artillery, solvents, septic sludges, and heavy metals).

CAS Identification

The initial identification, description, and listing of CASs at TTR were derived from the Preliminary Assessment (PA) and the *Federal Facility Preliminary Assessment Review* (E&E 1989). In 1993, the potential TTR CASs identified in the PA were subdivided into four “Soil Sites CAUs” and 43 “Industrial Sites CAUs.” Twelve additional potential CASs not included in the PA were also identified. These CASs were identified through:

- ER sites inventory process,
- Ordnance removal activities,
- Geophysical surveys,
- Former worker interviews,
- Archive reviews,
- Site visits, and
- Aerial radiological and multispectral surveys (1993 to 1996).

The remediation activities at the Clean Slate and Double Tracks sites (Project Roller Coaster) are discussed in Chapter 1. These sites are listed under Soil Sites in Table 3-1 as CAU-411, -412, -413, and -414.

Table 3-1 summarizes the existing Industrial and Soil Sites CAUs and CASs at the TTR. The ER activities planned for these CASs range from “no activities currently planned” to “NDEP-approved

closure.” The CAS information presented in the table is contained in Appendices II, III, and IV of the FFACO (DoD/DOE 1996).

2000 ER Activities

In 2000, cleanup at ER sites generated a total of 1,488 kg of primarily (non-RCRA waste) and 2,614 kg of RCRA waste. A total of 16,474 kg of ER Waste was shipped off-site. RCRA waste included rinsate, personal protective equipment (PPE), sampling debris, and field-testing kits. All RCRA-hazardous waste is shipped off-site to permitted treatment, storage, and disposal (TSD) facilities. Construction debris is disposed of at the U.S. Air Force (USAF) sanitary landfill. A total of 12,372 kg of low-level waste (LLW) was generated by ER activities in 2000 (Table 3-2). Westinghouse participates in environmental cleanup and restoration activities.

3.2

WASTE MANAGEMENT PROGRAMS

All waste generated by Sandia Corporation activities at TTR is managed by Westinghouse under the Waste Management Program. (Sandia Corporation does not handle waste generated by ER activities.) Waste categories include radioactive waste, RCRA-hazardous waste, other chemical waste, and non-hazardous solid waste. Waste minimization and recycling efforts are integrated into Waste Management Program activities. Westinghouse has 14 certified personnel who also perform hazardous waste sampling, as required.

Waste generated and handled by Sandia Corporation at TTR in 2000 was as follows:

Waste Type	Weight
RCRA waste	1,055 kg
Non-hazardous chemical waste	3,152 kg
Radioactive waste	2,790 kg

Sandia Corporation shipped all regulated waste to off-site permitted TSD facilities.

TABLE 3-1. NVOO ER Project TTR CAUs and CASs Calendar Year 2000 Status

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-400 - Closed		
Bomblet Pit and Five Points Landfill, TTR		
TA-19-001-05PT	Ordnance Disposal Pit	Five Points Intersection
TA-55-001-TAB2	Ordnance Disposal Pit	Bunker 2 Road
CAU-401 - Closed		
Area 3 Gas Station UST Site, TTR		
03-02-003-0357	UST, Gas	First Gas Station, Area 3
CAU-402 - Closed		
Area 3 Bldg. 0353 UST Site, TTR		
03-02-001-0353	UST, Diesel	Bldg. 0353
CAU-403 - Closed		
Area 3 Second Gas Station UST, TTR		
03-02-004-0360	USTs	Second Gas Station
CAU-404 - Closed		
Roller Coaster Lagoons and Trench, TTR		
TA-03-001-TARC	Roller Coaster Lagoons	NW of Antelope Lake
TA-21-001-TARC	Roller Coaster North Disposal Trench	NW of Antelope Lake
CAU-405		
Area 3 Septic Systems, TTR		
03-05-002-SW03	Septic Waste System	Area 3
03-05-002-SW04	Septic Waste System	Area 3
03-05-002-SW07	Septic Waste System	Area 3
CAU-406 - Closed		
Area 3 Bldg. 03-74 and Bldg. 03-58 UDPs, TTR		
03-51-002-0374	Heavy Duty Shop UDP, Sumps	Bldg. 0374
03-51-003-0358	UPS Building UDP	UPS Building, Area 3
CAU-407		
Roller Coaster Rad Safe Area, TTR		
TA-23-001-TARC	Roller Coaster Rad Safe Area	Northwest of Antelope Lake
CAU-408		
Bomblet Target Area, TTR		
TA-55-002-TAB2	Bomblet Target Areas	Antelope Lake

SOURCE: DoD/DOE 1996 and ongoing updates

NOTE: NVOO = Nevada Operations Office

CAU = Corrective Action Unit

CAS = Corrective Action Site

UDP = underground discharge point

UST = underground storage tank

ER = Environmental Restoration

TABLE 3-1. NVOO ER Project TTR CAUs and CASs Calendar Year 2000 Status (continued)

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-409		
Other Waste Sites, TTR		
RG-24-001-RGCR	Battery Dump Site	Cactus Repeater
TA-53-001-TAB2	Septic Sludge Disposal Pit	Bunker 2
TA-53-002-TAB2	Septic Sludge Disposal Pit	Bunker 2
CAU-410		
Area 9 Underground Vault and Disposal Trench, TTR		
09-21-001-09MG	Former Bunker or Underground Vault	East of Area 9 Magazines
09-21-001-TA09	Disposal Trenches	Area 9
TA-19-002-TAB2	Debris Mound	Bunker 2
TA-21-003-TANL	Disposal Trench	NEDS Lake
TA-21-002-TAAL	Disposal Trench	South Antelope Lake
CAU-423 - Closed		
Area 3 UDP, Bldg. 0360, TTR		
03-02-002-0308	UDP	Bldg. 0360
CAU-424 - Closed		
Area 3 Landfill Complex, TTR		
03-08-001-A301	Landfill Cell A3-1	Area 3 Landfill Complex
03-08-002-A302	Landfill Cell A3-2	Area 3 Landfill Complex
03-08-002-A303	Landfill Cell A3-3	Area 3 Landfill Complex
03-08-002-A304	Landfill Cell A3-4	Area 3 Landfill Complex
03-08-002-A305	Landfill Cell A3-5	Area 3 Landfill Complex
03-08-002-A306	Landfill Cell A3-6	Area 3 Landfill Complex
03-08-002-A307	Landfill Cell A3-7	Area 3 Landfill Complex
03-08-002-A308	Landfill Cell A3-8	Area 3 Landfill Complex
CAU-425		
Area 9 Main Lake Construction Debris Disposal Area, TTR		
09-08-001-TA09	Construction Debris Disposal Area	Area 9/Main Lake
CAU-426 - Closed		
Cactus Spring Waste Trenches, TTR		
RG-08-001-RGCS	Waste Trenches	Cactus Spring Ranch
CAU-427 - Closed		
Area 3 Septic Waste Systems 2 and 6, TTR		
03-05-002-SW02	Septic Waste System No. 2	Area 3
03-05-002-SW06	Septic Waste System No. 6	Area 3
CAU-428		
Area 3 Septic Waste Systems 1 and 5, TTR		
03-05-002-SW01	Septic Waste System No. 1	Area 3
03-05-002-SW05	Septic Waste System No. 5	Area 3

SOURCE: DoD/DOE 1996 and ongoing updates

NOTE: NVOO = Nevada Operations Office

CAU = Corrective Action Unit

CAS = Corrective Action Site

DU = depleted uranium

UDP = underground discharge points

ER = Environmental Restoration

TABLE 3-1. NVOO ER Project TTR CAUs and CASs Calendar Year 2000 Status (continued)

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-429 - Closed Area 3 Bldg. 03-55 and Area 9 Bldg. 09-52 UDPs, TTR		
03-51-001-0355	Photo Shop UDPs, Drains	Photo Shop Area 3
09-51-001-0952	Mobile Photographic Lab UDPs	Area 9
CAU-430 - Closed DU Artillery Round #1, TTR		
TA-55-003-0960	DU Artillery Round	South of Area 9
CAU-453 - Closed Area 9 UXO Landfill, TTR		
09-55-001-0952	Area 9 Landfill	Area 9
CAU-461 - Closed Test Area JTA Sites, TTR		
TA-52-002-TAML	DU Impact Site	Main Lake
TA-52-003-0960	DU Artillery Round #2	South of Area 9
TTR-001	1987 W-79 JTA	Unknown – South of Area 9
CAU-484 Antelope and NEDS Lakes Waste Sites, TTR		
TA-52-001-TANL	NEDS Detonation Area	NEDS Lake
TA-52-004-TAAL	Metal Particle Dispersion Test	Antelope Lake
TA-52-005-TAAL	JTA DU Sites	Antelope Lake
TA-54-001-TANL	Rocket Propellant Burn Area	NEDS Lake
RG-52-007-TAML	Davis Gun Site – Mellan	Test Range
TA-52-006-TAPL	Du Surface Debris	Colimbo Detonation Area, NEDS Lake
CAU-485 - Closed Cactus Spring Ranch Pu and DU Site, TTR		
TA-39-001-TAGR	Cactus Spring Ranch, Soil Contamination	West of Target Areas
CAU-486 - Closed Double Tracks Rad Safe Area, Nellis Range 71 North		
71-23-001-71DT	Double Tracks Rad Safe Area	Nellis Range 71 North
CAU-487 Thunderwell Site, TTR		
RG-26-001-RGRV	Thunderwell Site	Thunderwell Site
CAU-489 WWII UXO Sites, TTR		
RG-55-001-RGMN	WWII Ordnance Site	Mellan Airstrip
RG-55-002-RGHS	WWII Ordnance Site	H-Site Road
RG-55-003-RG36	WWII Ordnance Site	Gate 36E

SOURCE: DoD/DOE 1996 and ongoing updates

NOTE: NVOO = Nevada Operations Office
 CAU = Corrective Action Unit
 CAS = Corrective Action Site
 JTA = Joint Test Assembly
 NEDS = Non-Explosive Destruction Site
 UXO = unexploded ordnance
 ER = Environmental Restoration

TABLE 3-1. NVOO ER Project TTR CAUs and CASs Calendar Year 2000 (concluded)

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-490		
Station 44 Burn Area, TTR		
RG-56-001-RGBA	Fire Training Area	Station 44
03-56-001-03BA	Fire Training Area	Area 3
03-58-001-03FN	Sandia Service Yard	Area 3
09-54-001-09L2	Solid Propellant Burn Site	Area 9
CAU-495 - Closed		
Unconfirmed JTA Sites, TTR		
TA-55-006-09SE	Buried Artillery Round	Test Area
TA-55-007-09SE	Buried Artillery Round	Test Area
CAU-496		
Buried Rocket Site – Antelope Lake, TTR		
TA-55-008-TAAL	Buried Rocket	Antelope Lake
CAU-499		
Hydrocarbon Spill Site, TTR		
RG-25-001-RD24	Hydrocarbon Spill Site	Radar 24 Site
Soil Sites CAUs/CASs:		
CAU-411		
Double Tracks Plutonium Dispersion, Nellis		
NAFR-23-01	Pu-contaminated Soil	Double Tracks
CAU-412		
Clean Slate I Plutonium Dispersion, TTR		
TA-23-01CS	Pu-Contaminated Soil	Clean Slates I
CAU-413		
Clean Slate II Plutonium Dispersion, TTR		
TA-23-02CS	Pu-Contaminated Soil	Clean Slates II
CAU-414		
Clean Slate III Plutonium Dispersion, TTR		
TA-23-03CS	Pu-Contaminated Soil	Clean Slates III

SOURCE: DoD/DOE 1996 and ongoing updates

NOTE: NVOO = Nevada Operations Office

CAU = Corrective Action Unit

CAS = Corrective Action Site

DU = depleted uranium

ER = Environmental Restoration

Pu = plutonium

TABLE 3-2. Low-Level Waste (LLW) Generated by the ER Project in 2000

Container	Isotope	Contents	Weight (kg)	Comments
1 - 55-gallon Steel drum*	Pu-239/240	PPE, plastic, debris	240	ER work at CAU 407
4 - B25 boxes*	Pu-239/240	Contaminated soil	12,132	ER work at CAU 486
TOTAL			12,372	

NOTE: PPE = personal protective equipment
 *Radioactive waste shipped to Nevada Test Site (NTS) for disposal in 2000.

Table 3-3 shows a detailed breakdown of the RCRA waste categories and quantities. Table 3-4 lists regulated non-RCRA waste categories and quantities. Table 3-5 lists waste categories transported off-site for recycling or alternative fuel use. A *Hazardous Waste Biennial Report* is prepared by SNL and submitted to the U.S Environmental Protection Agency (EPA) through NVOO (SNL 2000).

Waste Minimization Program

TTR is committed to achieving significant reductions in the amount of chemical and hazardous wastes generated on-site. Waste minimization includes recycling and recovery of the following materials:

- Solvents,
- Fuels,
- Oil,
- Antifreeze (on-site recycling unit),
- Lead acid batteries,
- Freon (on-site recovery unit),
- Fluorescent and sodium bulbs, and
- Mercury-containing equipment.

Radioactive Waste Management

Sandia Corporation did not generate any radioactive waste in 2000. However, radioactive waste was generated by remediation of ER sites under the cognizance of NVOO.

3.3 SPILL PREVENTION CONTROL AND COUNTER-MEASURES (SPCC) PLAN

The *SPCC Plan for SNL Tonopah Test Range* (SNL 1999), which was revised in 1999, pertains to oil storage equipment and secondary containments subject to 40 CFR 112, "Oil Pollution Prevention" and 40 CFR 110, "Discharge of Oil."

There are three aboveground storage tanks (ASTs), two Bulk Storage Areas (BSA), and one transformer storage area that are regulated with a capacity >660 gallons that are applicable to the SPCC Plan at TTR. A leak from the secondary containment structure on the AST at Building 03-53 was observed and reported to TTR personnel during the May 2000 annual SPCC inspection. Minor maintenance on some of the facilities was recommended and documented during the annual SPCC inspection dated July 2000.

3.4 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) PROGRAM

NEPA Activities at TTR

At TTR, NEPA compliance is a joint effort by Sandia Corporation in Nevada, Sandia Corporation in New Mexico, and DOE Kirtland Area Office (KAO). Additionally, under the direction of Sandia Corporation, compliance is supported by the Water Resources Center at the

TABLE 3-3. Sandia Corporation Tonopah Test Range (TTR) Generated RCRA-Regulated Hazardous Waste Shipped Off-site in 2000

Waste Description	Waste Codes	Generated (kg)
WASTE MANAGEMENT		
NOS, Petroleum distillates (petroleum naphtha)	D001	70
NOS, Toxic liquid, organic, (neutralizing agent & battery acid)	D008	28
NOS, (rags with methylene chloride)	F002, F003, F005, D035	212
NOS, Corrosive liquid, basic, inorganic (photographic developer)	D002	20
NOS, Flammable liquids (Lab Pack)	D001, D018	102
Vapor bulbs (mercury)	D009, D002	8
Aerosols flammable (petroleum distillates)	D001	48
Battery (Lithium)	D001, D008	5
Lead Practice Grenade Ballasts	D008	208
Gasoline	D001, D018	52
Diesel Fuel	D001, D018, D008	278
Sodium Vapor Bulbs	D005	14
Lithium Battery	D001, D008	5
Waste mercury (Lab Pack)	D002, D009	5
TOTAL		1,055
ENVIRONMENTAL RESTORATION (ER)		
NOS, hazardous solid, (soil, PPE, sampling debris from ER work)	F003	32
NOS, (soil, PPE sampling debris from field test kit)	D019	32
Hazardous waste (Silver contaminated septage)	D011	2,550
TOTAL		2,614

NOTE: NOS = not otherwise specified
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery Act

Desert Research Institute (DRI) through the University of Nevada System. DRI prepares archaeological and biological surveys and reports. Final reports are submitted to Sandia Corporation for transmittal to DOE/KAO for review and decision making and consultation with state and federal agencies.

The final Environmental Impact Statement (EIS), which includes the TTR site, was completed in 1996; the DOE Record of Decision (ROD) was filed on December 9, 1996 (DOE 1996b).

3.5 ENVIRONMENTAL MONITORING PERFORMED BY OUTSIDE AGENCIES

In addition to Sandia Corporation, other agencies perform environmental monitoring activities at TTR as described below.

EPA

The EPA Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, under an interagency agreement with DOE, monitors background radiation in the vicinities of TTR as part of its Off-site Radiation Monitoring Reports Program. Reports are available through the EPA upon request. Two major EPA reports are as follows:

TABLE 3-4. Non-RCRA-Regulated Hazardous or Toxic Waste Shipped Off-site in 2000

Waste Description	Generated (kg)
WASTE MANAGEMENT	
Non-flammable aerosols	4
Used (large) alkaline batteries	366
Incandescent light bulbs	38
Oil contaminated rags	68
Separator pit clean-out	514
Used Oil filters	154
Oil filled capacitor (non-PCB)	44
Used Oil	1616
Lead Acid Batteries	254
Fluorescent Bulbs	94
TOTAL	3,152
ENVIRONMENTAL RESTORATION (ER)	
PPE/Plastic	245
Rinsate	1,089
hydrocarbon impacted soil and debris	154
TOTAL	1,488

NOTE: PPE = personal protective equipment
 PCB = polychlorinated biphenyls
 RCRA = Resource Conservation and Recovery Act

TABLE 3-5. Recycled Regulated Hazardous or Toxic Waste Shipped Off-site in 2000

Recycled Material or Energy Recovered Material	Generated (kg)
WASTE MANAGEMENT	
Photographic developer	20
Mercury vapor bulbs	8
Lithium batteries	5
Waste petroleum distillates	70
Mercury vapor bulbs	8
Lab Pack (flammable liquids)	102
Lab Pack (mercury contained in manufactured articles)	5
Lead Acid Batteries	254
Fluorescent Bulbs	94
Used Oil	1616
Gasoline	52
Diesel Fuel	278
Lead Practice Grenade Ballasts	208
Waste combustible liquid, NOS, petroleum naphtha	70
TOTAL	2,790
ENVIRONMENTAL RESTORATION (ER)	
ER waste	0
TOTAL	0

NOTE: NOS = not otherwise specified



Chapter 4

Terrestrial Surveillance and Water Monitoring

Terrestrial surveillance is conducted at the Tonopah Test Range (TTR) to detect the possible migration of contaminants to off-site locations and to determine the potential impact of Sandia Corporation's operations on human health or the environment.

Sandia Corporation monitors drinking water supplies at TTR to ensure that State of Nevada drinking water regulations are met. Wastewater sampling is conducted annually to ensure that Sandia Corporation's releases to the sanitary sewer system meet the requirements of the National Pollution Discharge Elimination System (NPDES), maintained by the U.S. Air Force (USAF). Septic systems are sampled, as needed.

Environmental monitoring and surveillance is conducted under the direction of the Environmental Management Department at Sandia Corporation, New Mexico. Westinghouse Government Services, the on-site contractor at TTR, performed or assisted in most environmental monitoring activities in 2000. These included the following routine environmental monitoring duties:

- Production Well 6 sampling;
- Wastewater sampling;
- Ambient air monitoring;
- Soil sampling at spill sites;
- Managing the thermoluminescent dosimeter (TLD) network; and
- Hazardous waste characterization.

4.1 TERRESTRIAL SURVEILLANCE

4.1.1 Program Objectives

The objectives of the Terrestrial Surveillance Program can be summarized by the following excerpts based on requirements given in U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Program* (DOE 1990):

- Collect and analyze samples to characterize environmental conditions and define increasing or decreasing trends.
- Establish background levels of pollutants to define baseline conditions (off-site sampling).
- Provide continuing assessment of pollution abatement programs.
- Identify and quantify new or existing environmental quality problems and their potential impacts, if any.
- Verify compliance with applicable environmental laws and regulations and commitments made in National Environmental Policy Act (NEPA) documents, such as Environmental Impact Statements (EISs), as well as other official documents.

4.1.2 Regulatory Standards and Comparisons

The Terrestrial Surveillance Program is designed and conducted in accordance with the requirements of DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990). Concentration limits for radionuclides and metals in terrestrial media are not well defined; however, Sandia Corporation, New Mexico does compare the results from on-site and perimeter locations to community (off-site) results to determine the impact, if any, of Sandia Corporation's operations on the environment.

4.1.3 Statistical Analyses

Samples are typically collected from fixed locations to effectively make statistical comparisons with results from previous years. Statistical analyses are performed to determine if a result is significantly different from off-site values or to determine if an increasing trend exists. Since multiple data points are necessary to provide an accurate view of a system, the Terrestrial Surveillance Program does not rely on the results from any single year's sampling event to characterize on-site environmental conditions. Furthermore, results from a single sampling point may vary from year to year, due to slight changes in sampling locations, differences in climatic conditions, and laboratory variations or errors. Therefore, as the amount of data increases, the accuracy of the characterization increases.

Statistical analysis can also detect patterns of migration, which may point to movement of contaminants either onto or off Sandia Corporation's property at TTR. Potential areas of concern are addressed with the appropriate program to minimize any effects.

To date, there have been no results that have indicated a significant level of concern that would trigger mitigation in areas that are not already being addressed by the Environmental Restoration (ER) Project.

4.2 SAMPLING LOCATIONS, PARAMETERS, AND TERRESTRIAL MEDIA

4.2.1 Sampling Locations

Terrestrial surveillance began at TTR in 1992. In addition to routine sampling, a large-scale baseline sampling was performed in 1994 in areas where Sandia Corporation had a long-term or continued presence. On-site, perimeter, and off-site sampling locations are listed in Tables 4-1, 4-2, and 4-3, respectively.

Routine terrestrial surveillance is conducted at on-site, perimeter, and off-site locations that remain essentially the same from year to year. Sample locations may be modified as necessary to reflect current operations or to supplement data from existing locations. For example, prior to 2000, locations T-20 and T-21 were used to monitor around an area contaminated with depleted uranium. That site has been remediated and the sampling locations were disturbed. Location T-21 was deleted from the Terrestrial Surveillance Program and, due to remediation efforts, T-20 was moved a short distance from the original sampling location.

The sampling locations, number of samples, and analyses performed are prioritized based on the following criteria:

- **On-site locations** are near areas of known contamination, potential sources of contamination, or in areas where contamination, if present, would be expected to accumulate, such as in the vicinity of ER sites. On-site sampling locations are shown in Appendix B. A total of 21 locations were sampled on-site.
- **Perimeter locations** are selected to establish if contaminants are migrating either onto or off Sandia Corporation property at TTR. The eight perimeter locations sampled are shown in Figure B-2 of Appendix B. All perimeter locations are in areas to which Sandia Corporation does not control access within TTR.

TABLE 4-1. On-site Terrestrial Surveillance Locations at TTR

Location Number	Sample Location	Replicate Location
South Plume		
T-14	N/S Mellan Airstrip – Antelope Tuff	Yes
T-16	N/S Mellan Airstrip – SW of T-14	
T-17	N/S Mellan Airstrip – sign post	
T-18	N/S Mellan Airstrip – NE of T-17	
T-19	NE of NW/SE Mellan Airstrip	
Range Operations Center		
OC-02	Waste Water Monitoring Station	
OC-03	“Danger Powerline Crossing” Sign	
OC-04	Main Road/Edward’s Freeway	
OC-10	SW Corner of Sandia Corporation, TTR Operations Center	
OC-13	NE Corner of Sandia Corporation, TTR Operations Center	
OC-19	Storage Shelters, 03-38/03-39	
OC-22	Sand Building	
OC-23	Generator Storage Area	
Various On-site Locations		
D-01	Roller Coaster Decon	Yes
MH-03	Mellan Hill – Metal Scrap Pile	
MH-04	Mellan Hill – North	
T-02	N/S Mellan Airstrip (TLD at south fence post)	
T-03	TLD at Clean Slate 2	Yes
T-04	TLD at Clean Slate 3	
T-10	Brownes Road/Denton Freeway	
T-20	Main Road/Lake Road SE	

NOTE: TLD = thermoluminescent dosimeter
 TTR = Tonopah Test Range

TABLE 4-2. Perimeter Terrestrial Surveillance Locations at TTR

Location Number	Sample Location	Replicate Location
OM-03	O&M Complex (Owan Drive post)	
T-06	Cedar Pass Road Guard Station	
T-08	On-Base Housing (Main guard gate/power pole CP17)	
T-11	Cactus Springs (north fence post)	
T-12	TLD at “US Gov’t Property” Sign	
T-13	Cactus Springs (TLD south of T-11)	
T-36	On-Base Housing (NE fence line)	
T-37	On-Base Housing (guard station)	

NOTE: TLD = thermoluminescent dosimeter
 TTR = Tonopah Test Range

TABLE 4-3. Off-site Terrestrial Surveillance Locations at TTR

Location Number	Sample Location	Replicate Location
B-01	Alkali/Silver Peak Turnoff	
B-02	Cattle Guard	
B-03	Tonopah Ranger Station	
B-04	State Road 6/95 Rest Area	
B-05	Gabbs Pole Line Road	
B-06	State Roads 6/376 Junction	
B-07	Rocket	
B-08	State Road 6 Rest Area	
B-09	Stone Cabin/Willow Creek	
B-10	State Roads 6 and 375 Junction	
B-11	State Road 375 Ranch Cattle Gate	
B-12	Golden Arrow/Silver Bow	
B-13	Five miles south of Rocket	
B-14	Nine miles south of Rocket	

NOTE: TTR = Tonopah Test Range

- **Community (Off-site) locations** are selected to provide a measurement of environmental conditions unaffected by Sandia Corporation's activities at TTR. Data collected from off-site locations serve as a reference point to compare data collected at perimeter and on-site locations. Multiple years of sampling data are compiled to determine statistical averages for off-site concentrations. Off-site locations are chosen both in remote, natural settings as well as in areas near local population centers and along highways. The 14 off-site locations sampled are shown in Figure B-1 of Appendix B.

4.2.2 Sample Media

Soil - Soil samples are collected to ascertain the presence of air-deposited pollutants or contaminants that have been transported and deposited as a result of surface water runoff. Samples are collected from the top two inches of soil using a hand trowel. In May 2000, soil samples were collected from the following 43 locations:

- 21 on-site,
- 8 perimeter, and
- 14 off-site.

Soil is the only terrestrial medium sampled at the TTR. There are no bodies of water, other than the Playa lakes (dry lake beds with only occasional standing water), and vegetation is scarce.

External gamma radiation exposure rates - In January 1994, Sandia Corporation began an ambient gamma radiation monitoring program as part of the Terrestrial Surveillance Program at TTR.

The Thermoluminescent Dosimeter (TLD) network is established to determine the regional gamma exposure rate due to natural sources and to determine the impact, if any, of Sandia Corporation's operations on these levels. Several natural sources of gamma radiation exist, including cosmic radiation and radioactive materials that exist in geologic materials. At TTR, man-made sources of gamma radiation include radioactively contaminated soils from past test activities and radiography operations in support of on-going tests.

The TLD's are placed on aluminum poles at a height of 1 to 1.5 m and are exchanged and measured quarterly (January, April, July, and October) at 13 on-site, four perimeter, and five off-site locations.

4.3 PRIORITIZATION ANALYSIS METHODOLOGY

Terrestrial surveillance results are assigned to four categories to aid in the decision-making process that will determine the level of concern warranted to each result. The Statistical Analysis Prioritization Method (Shyr, Herrera, and Haaker 1998) is based on two "yes or no" questions, resulting in a matrix of four answers labeled Category 1 (CAT-1), Category 2 (CAT-2), Category 3 (CAT-3), and Category 4 (CAT-4). The decision matrix is shown in Table 4-4. A CAT-1 designation is the most significant concern level, indicating contaminants at an on-site or perimeter location that were both statistically higher than off-site values and demonstrating an increasing trend. (There have been no CAT-1 results to date.) A CAT-2 designation indicates an on-site or perimeter result that is higher than off-site values, with no indication of an increasing trend. A CAT-3 designation indicates an on-site or perimeter location with an increasing trend, but a concentration that is not statistically greater than off-site values. A CAT-4 designation indicates a sample result that is statistically equivalent to off-site values with no increasing trend; therefore, no concern is warranted.

Any CAT-2 or CAT-3 result is compared against U.S. Soil Surface Concentrations, where applicable. Formerly, CAT-2 or CAT-3 metal results were also compared to the Resource Conservation and Recovery Act (RCRA) Subpart S Action Level, but those values were rescinded in October 1999 and are no longer utilized by the Terrestrial Surveillance Program.

4.4 RADIOLOGICAL PARAMETERS AND RESULTS

4.4.1 Radiological Parameters

Radiological analysis is performed on all soil samples. The Calendar Year (CY) 2000 analytical results are shown in Appendix B of this report. In addition, the detailed statistical analyses are published in *Tonopah Test Range Data Analysis in Support of the Annual Site Environmental Report 2000* (SNL 2001b). Radiological analyses include the following:

- **Gamma-emitting radionuclides** – gamma spectroscopy is used to detect the emission of gamma radiation from radioactive materials. Radionuclide identification is possible by measuring the spectrum of gamma energies associated with a sample, since each radionuclide has a unique and consistent series of gamma emissions. Cesium-137 (Cs-137) is an example of a long-lived gamma emitter that is prevalent in the environment (as fallout from historical nuclear weapons testing). Other gamma-emitters of interest at TTR are Americium-241 (Am-241) and depleted uranium (DU) from past explosives testing.
- **Plutonium** – Due to past explosive testing, plutonium is present in some areas of TTR. One of the indicators of the presence of weapons-grade plutonium is the radionuclide Am-241. Isotopic plutonium analysis is normally performed on any sample for which gamma spectroscopy identified Am-241 in concentrations greater than its minimum detectable activity (MDA).
- **Uranium** – Uranium occurs naturally in soils and may also be present as a pollutant in the environment due to past testing conducted at TTR. Total uranium (U_{tot}) analysis is used to measure all uranium isotopes present in a sample. A high U_{tot}

TABLE 4-4. Decision Matrix for Determining Priority Action Levels Based on Categories Assigned at Each Sampling Location

Category	Are results higher than off-site?*	Is there an increasing trend over the last 9 years?	Priority for Further Investigation
1	Yes	Yes	1st Priority - Immediate attention needed. Specific investigation planned and/or notifications made to responsible parties.
2	Yes	No	2nd Priority - Some concern based on the level of contaminant present. This may be from a known site of contamination already being addressed under the ER Project. Investigation planned and/or notifications made to responsible parties.
3	No	Yes	3rd Priority - A minor concern since contaminants present are not higher than off-site averages. An investigation may or may not be needed.
4	No	No	4th Priority - No concern. No investigation required.

NOTE: Based on Prioritization Statistical Analysis Methodology (Shyr, Herrera, and Haaker 1998).

*While some sites may appear higher than off-site, there may not be a statistically significant difference.

measurement may trigger an isotope-specific analysis to determine the possible source of uranium (i.e., natural, man-made, enriched, or depleted).

4.4.2 Overview Discussion of Radiological Results

There were no on-site or perimeter locations identified as CAT-1 or CAT-2 for any radiological parameter. Table 4-5 shows the summary statistics for soil samples between 1991 and 2000. Only one location (D-01) was identified as CAT-3 for Am-241 (Table 4-6). The remaining locations are CAT-4 for all radiological parameters.

The statistical analysis showed multiple locations with decreasing trends for Cs-137, Am-241, and/or U_{tot}. Decreasing trends have been noted in the past, but were more prevalent this year due to a change in the analytical

laboratory used by the Terrestrial Surveillance Program and a resulting decrease in detection limits and reported results for many analytes. To avoid masking a possible increasing trend in the future, the time period for data analysis may need to change the start date to one that is later than 1996 to compensate for the lower reported results.

4.4.3 TLD Results

Sampling for 2000 was conducted from January 5, 2000 to January 8, 2001. Table 4-7 shows the summary statistics by location type from 1994 to 2000. On-site and perimeter locations are statistically indistinguishable from off-site locations. Figure 4-1 graphically portrays the TLD results from 1994 to 2000. TLD results and TLD measurements by quarter and location type for 2000 are shown in Tables B-7 and B-8 of Appendix B, respectively.

TABLE 4-5. Radiological Summary Statistics for Soil Samples 1991 to 2000

Analyte	Location Type	Units	Sample Size	Average	Median	Std Dev	Min	Max	Locations Identified As:	
									CAT-2 Higher than Off-site	CAT-3 Increasing Trend
Am-241	On-site	pCi/g	78	0.177	0.040	0.652	-0.60	4.40		D-01
	Perimeter	pCi/g	24	0.022	0.019	0.064	-0.122	0.175		
	Off-site	pCi/g	43	0	-0.001	0.046	-0.152	0.103		
Cs-137	On-site	pCi/g	143	0.35	0.35	0.28	-0.85	1.00		
	Perimeter	pCi/g	56	0.26	0.22	0.21	-0.09	0.73		
	Off-site	pCi/g	97	0.30	0.22	0.26	0	1.43		
K-40	On-site	pCi/g	105	35.65	35.0	4.90	20	46		
	Perimeter	pCi/g	40	35.42	35.3	4.86	22.5	45		
	Off-site	pCi/g	70	32.91	32.1	5.16	16.2	45		
Pu-238	On-site	pCi/g	53	0.03	0.02	0.05	-0.08	0.23		
	Perimeter	pCi/g	19	0.02	0.01	0.06	-0.08	0.19		
	Off-site	pCi/g	27	0.01	0.01	0.04	-0.05	0.11		
Pu-239/240	On-site	pCi/g	53	1.62	0.17	4.57	-0.02	32.0		
	Perimeter	pCi/g	19	0.06	0.04	0.11	-0.02	0.50		
	Off-site	pCi/g	27	0.01	0	0.02	-0.03	0.06		
U _{tot}	On-site	µg/g	145	2.25	2.52	1.29	0.287	5.5		
	Perimeter	µg/g	56	2.00	2.20	1.21	0.301	5.0		
	Off-site	µg/g	97	2.25	2.40	1.32	0.301	6.0		

NOTE: Isotopic Plutonium was not analyzed at the analytical laboratory in 2000. Summary statistics reflect data only through 1999 for Plutonium-238 and Plutonium 239/240.
 pCi/g = picocurie per gram
 µg/g = microgram per gram
 Std Dev = Standard Deviation

TABLE 4-6. Summary Statistics for Soil locations noted as CAT-3 for Am-241 (all units in pCi/g)

Analyte	Location	Sample Size	Average	Std Dev	Min	Max
Am-241	D-01	6	1.05	1.25	0.35	3.58

NOTE: pCi/g = picocurie per gram
 Std Dev = Standard Deviation

TABLE 4-7. Summary of TLD Measurements for 1994 to 2000

Location Class	# Years	Units	Mean	Std Dev	Minimum	Maximum
On-site	7	mrem/yr	146.3	10.8	125.1	158.7
Perimeter	7	mrem/yr	142.9	9.7	128.4	154.9
Off-site	7	mrem/yr	133.3	16.6	108.0	154.5

NOTE: mrem/yr = millirem per year
 Std Dev = Standard Deviation

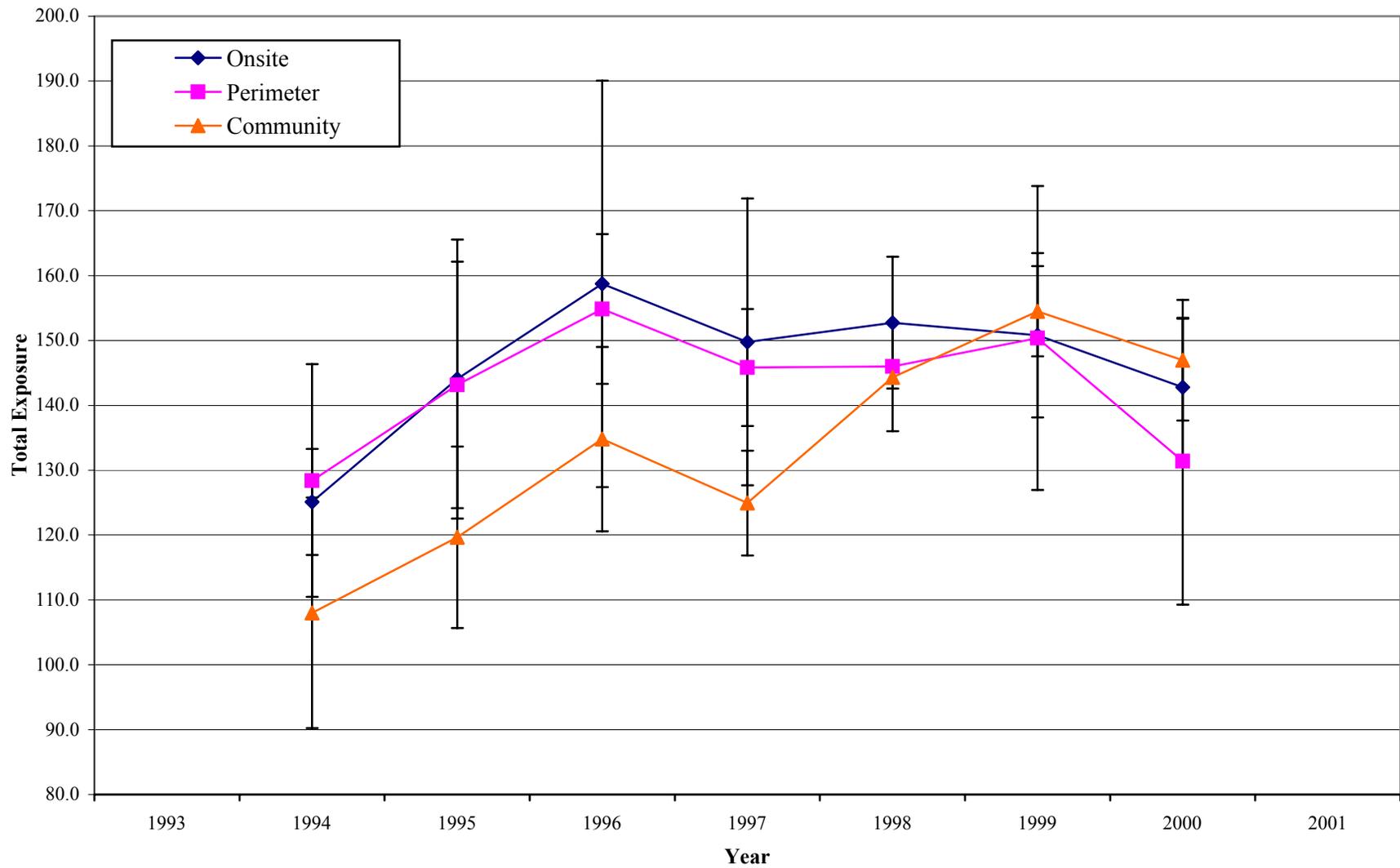


FIGURE 4-1. Thermoluminescent Dosimeter (TLD) Average Annual Results for TTR From 1994 to 2000

4.5 NON-RADIOLOGICAL PARAMETERS AND RESULTS

4.5.1 Non-radiological Parameters

TTR non-radiological soil analyses are scheduled to occur during even numbered years (every other year). In 2000, all soil samples were analyzed for 20 stable metals (ICP-20) plus mercury. All metals are quantified using the Inductively Coupled Plasma-Atomic Emission Spectrum (ICP-AES) method, except for mercury. The ICP-AES method is used when samples are super-heated to a plasma state and individual elements can be identified by the atomic emission spectrum that they emit.

ICP-20 Metals

The list of 21 metals has been modified over time to best represent a broad range of toxic pollutant indicators based on RCRA and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) target list metals. For example, calcium, silicon, strontium, and titanium were removed from the list since they are naturally abundant in the soil and are not useful indicators of pollution. These metals were replaced with more representative indicators (i.e., thallium, selenium, arsenic, and antimony). The current list of 21 metals including mercury is as follows:

Aluminum (Al)	Antimony (Sb)
Arsenic (As)	Barium (Ba)
Beryllium (Be)	Cadmium (Cd)
Chromium (Cr)	Cobalt (Co)
Copper (Cu)	Iron (Fe)
Lead (Pb)	Manganese (Mn)
Magnesium (Mg)	Mercury (Hg)
Nickel (Ni)	Potassium (K)
Selenium (Se)	Silver (Ag)
Thallium (Tl)	Vanadium (V)
Zinc (Zn)	

Non-radiological results for these locations were assigned categorized from CAT-1 to CAT-4 (refer to section 4.3 and Table 4-4 for categorical description) for metals based on a

comparison of concentrations between on-site, perimeter, and off-site locations. In 2000, there were no sites designated as CAT-1. Locations categorized as CAT-4 are not discussed because they are of no environmental concern.

The CY00 analytical results are shown in Appendix B of this report. In addition, the detailed statistical analyses are published in *Tonopah Test Range Data Analysis in Support of the Annual Site Environmental Report 2000* (SNL 2001b).

4.5.2 Overview Discussion of Non-radiological Results

All non-radiological results are presented in Appendix B. There were no locations identified as CAT-1 for any non-radiological parameter. Five different locations were identified as CAT-2 for at least one metal. Two on-site locations were identified as CAT-3 for at least one metal.

The statistical analysis indicated that the following metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, mercury, potassium, silver, thallium, and vanadium) were CAT-4 at all sampling locations. One off-site location (B-10) was also identified as CAT-3 for lead.

Table 4-8 shows the non-radiological summary statistics for soil samples between 1994 and 2000. Soils were not analyzed for metals during the 1997 sample period. Tables 4-9 through 4-13 show the summary statistics for the locations identified as either CAT-2 or CAT-3 in 2000.

The statistical analysis showed multiple locations with a decreasing trend for multiple non-radiological parameters. Decreasing trends have been noted in the past, but were more prevalent this year with the change in analytical laboratory and a resulting decrease in detection limits and reported results for many analytes. To avoid masking a possible increasing trend, the time period for data analysis may need to

TABLE 4-8. Non-radiological Summary Statistics for Soil Samples 1994 to 2000

Analyte	Location Type	Units	Sample Size	Average	Median	Std Dev	Min	Max	Locations Identified As:	
									CAT-2 Higher than Off-site	CAT-3 Increasing Trend
Aluminum	On-site	mg/kg	125	7866	7110	2844	3310	19300		
	Perimeter	mg/kg	48	5805	5170	2138	2890	11800		
	Off-site	mg/kg	83	6937	6690	2177	3600	12700		
Antimony	On-site	mg/kg	63	1.840	0.191	2.32	0.0815	5		
	Perimeter	mg/kg	24	1.766	0.191	2.33	0.0815	5		
	Off-site	mg/kg	42	1.800	0.191	2.35	0.0815	5		
Arsenic	On-site	mg/kg	84	7.11	5.22	4.85	1.70	20		
	Perimeter	mg/kg	32	7.62	6.43	6.22	1.25	27		
	Off-site	mg/kg	56	8.08	5.69	7.92	0.88	43		
Barium	On-site	mg/kg	125	131.8	120.0	47.7	65.2	339		
	Perimeter	mg/kg	48	100.2	97.5	27.3	56.3	160		
	Off-site	mg/kg	83	146.9	131.0	91.3	68.8	810		
Beryllium	On-site	mg/kg	125	0.50	0.5	0.13	0.253	1.2		
	Perimeter	mg/kg	48	0.49	0.5	0.17	0.183	1.2		
	Off-site	mg/kg	83	0.47	0.5	0.13	0.213	1.0		
Cadmium	On-site	mg/kg	125	0.47	0.5	0.44	0.038	4.4	OC-19	
	Perimeter	mg/kg	48	0.38	0.5	0.21	0.019	0.7		
	Off-site	mg/kg	83	0.41	0.5	0.24	0.019	1.4		
Chromium	On-site	mg/kg	125	12.04	8.0	11.47	1.69	72		
	Perimeter	mg/kg	48	12.36	9.4	11.60	1.43	42		
	Off-site	mg/kg	83	10.91	7.1	9.68	1.61	48		
Cobalt	On-site	mg/kg	104	3.43	3.20	1.08	1.77	6.50	D-01	
	Perimeter	mg/kg	40	2.75	2.57	1.34	0.918	6.42		
	Off-site	mg/kg	69	3.01	2.90	1.01	1.03	5.40		
Copper	On-site	mg/kg	104	6.54	6.00	2.52	2.81	15.0		
	Perimeter	mg/kg	40	5.65	4.42	4.15	1.71	20.9		
	Off-site	mg/kg	69	7.15	6.50	3.61	1.64	18.0		
Iron	On-site	mg/kg	125	8957	8510	2917	4090	22100		
	Perimeter	mg/kg	48	7754	7085	3664	3460	23800		
	Off-site	mg/kg	83	7930	7450	2458	3820	16800		
Lead	On-site	mg/kg	125	13.40	10.30	26.65	4.68	306		
	Perimeter	mg/kg	48	9.42	8.91	5.07	0.50	20		
	Off-site	mg/kg	83	13.96	12.00	8.76	4.51	57.3		B-10
Magnesium	On-site	mg/kg	125	3247	2960	1154	1560	8100		
	Perimeter	mg/kg	48	2163	1925	923	1060	5790		
	Off-site	mg/kg	83	3421	3080	2358	1260	18000		

NOTE: Metals were not analyzed during the 1997 sample period.
mg/kg = milligram per kilogram
Std Dev = Standard Deviation

TABLE 4-8. Non-radiological Summary Statistics for Soil Samples 1994 to 2000 (concluded)

Analyte	Location Type	Units	Sample Size	Average	Median	Std Dev	Min	Max	Locations Identified As:	
									CAT-2 Higher than Off-site	CAT-3 Increasing Trend
Manganese	On-site	mg/kg	125	351	330	134	172	1330	MH-04	
	Perimeter	mg/kg	48	330	323	204	111	1060	T-11	
	Off-site	mg/kg	83	307	300	105	114	551		
Mercury	On-site	mg/kg	42	0.055	0.062	0.045	0.005	0.1		
	Perimeter	mg/kg	16	0.055	0.058	0.047	0.005	0.1		
	Off-site	mg/kg	28	0.055	0.060	0.046	0.004	0.1		
Nickel	On-site	mg/kg	125	4.93	4.1	1.96	1.99	15		OC-04
	Perimeter	mg/kg	48	3.99	4.0	2.30	1.29	15		
	Off-site	mg/kg	83	4.94	4.0	3.27	1.66	22		
Potassium	On-site	mg/kg	125	3183	2900	1151	1440	7500		
	Perimeter	mg/kg	48	2268	2200	610	1250	3900		
	Off-site	mg/kg	83	2771	2780	875	500	5300		
Selenium	On-site	mg/kg	63	1.987	0.146	2.67	0.135	8		
	Perimeter	mg/kg	24	1.808	0.146	2.40	0.135	6		
	Off-site	mg/kg	42	2.026	0.146	2.74	0.135	7		
Silver	On-site	mg/kg	125	0.59	0.5	0.75	0.031	5		
	Perimeter	mg/kg	48	0.57	0.5	0.63	0.031	3		
	Off-site	mg/kg	83	0.60	0.5	0.61	0.031	3		
Thallium	On-site	mg/kg	83	9.03	5.110	10.39	0.205	33		
	Perimeter	mg/kg	32	5.86	0.221	6.07	0.205	18		
	Off-site	mg/kg	51	6.25	0.221	7.67	0.205	27		
Vanadium	On-site	mg/kg	125	14.23	13.00	5.32	4.78	36		
	Perimeter	mg/kg	48	11.15	9.05	6.74	4.05	39		
	Off-site	mg/kg	83	13.69	12.00	7.36	4.03	47		
Zinc	On-site	mg/kg	125	43.7	33.0	37.2	13.5	260	OC-13, OC-19	
	Perimeter	mg/kg	48	33.5	29.0	17.8	13.8	93		T-37
	Off-site	mg/kg	83	32.0	29.7	13.8	10.2	87		

NOTE: Metals were not analyzed during the 1997 sample period.
 mg/kg = milligram per kilogram
 Std Dev = Standard Deviation

TABLE 4-9. Summary Statistics for Soil Locations for Cadmium (all units in mg/kg)

Analyte	Category	Location	Sample Size	Average	Std Dev	Min	Max
Cadmium	CAT-2	OC-19	6	1.6	1.5	0.5	4.4

NOTE: mg/kg = milligram per kilogram
 Std Dev = Standard Deviation

TABLE 4-10. Summary Statistics for Soil Locations for Cobalt (all units in mg/kg)

Analyte	Category	Location	Sample Size	Average	Std Dev	Min	Max
Cobalt	CAT-2	D-01	5	5.79	0.79	4.44	6.50

NOTE: mg/kg = milligram per kilogram
 Std Dev = Standard Deviation

TABLE 4-11. Summary Statistics for Soil Locations for Manganese (all units in mg/kg)

Analyte	Category	Location	Sample Size	Average	Std Dev	Min	Max
Manganese	CAT-2	MH-04	6	525.5	77.7	430	610
	CAT-2	T-11	6	704.5	227.6	422	1060

NOTE: mg/kg = milligram per kilogram
Std Dev = Standard Deviation

TABLE 4-12. Summary Statistics for Soil Locations for Nickel (all units in mg/kg)

Analyte	Category	Location	Sample Size	Average	Std Dev	Min	Max
Nickel	CAT-3	OC-04	6	4.84	1.34	4	7.03

NOTE: mg/kg = milligram per kilogram
Std Dev = Standard Deviation

TABLE 4-13. Summary Statistics for Soil Locations for Zinc (all units in mg/kg)

Analyte	Category	Location	Sample Size	Average	Std Dev	Min	Max
Zinc	CAT-2	OC-13	6	102.2	37.0	43	135
	CAT-2	OC-19	6	118.0	65.0	54.2	196
	CAT-3	T-37	6	29.1	9.5	20	43.9

NOTE: mg/kg = milligram per kilogram
Std Dev = Standard Deviation

change the start date to one that is later than 1996 to compensate for the lower reported results.

Cadmium

One on-site location (OC-19) located near the storage shelters 03-38/03-39 within the Range Operations Center was identified as CAT-2 for cadmium. The average concentration at OC-19 was 1.6 mg/kg. It should be noted that this high average is caused by a maximum result of 4.4 mg/kg recorded in 1994. Excluding this value, the value of cadmium ranges from 0.5 mg/kg to 1.8 mg/kg with an average concentration of 0.99 mg/kg. The off-site average concentration was 0.41 mg/kg. Summary statistics for iron at this location are presented in Table 4-9. For comparison, the

U.S. Surface Soil concentration for cadmium ranges from 0.41 mg/kg to 0.57 mg/kg.

Cobalt

One on-site location (D-01) located near the Roller Coaster Decontamination area was identified as CAT-2 for cobalt. The average concentration at D-01 was 5.79 mg/kg. The off-site average concentration was 3.00 mg/kg. Summary statistics for cobalt at this location are presented in Table 4-10. For comparison, the U.S. Surface soil concentration for cobalt ranges from 3 mg/kg to 50 mg/kg.

Manganese

One on-site location (MH-04) located near Mellan Hill and one perimeter location (T-11) located near Cactus Springs were identified as CAT-2 for manganese. The average

concentration at MH-04 was 525 mg/kg, and the average concentration at T-11 was 704 mg/kg. The off-site average concentration was 307 mg/kg. Summary statistics for manganese at these locations are presented in Table 4-11. For comparison, the U.S. Surface Soil concentration for manganese ranges from 20 mg/kg to 3,000 mg/kg.

Nickel

One on-site location (OC-04) located at the intersection of the Main Road and Edward’s Freeway was identified as CAT-3 for nickel. The average concentration at OC-04 was 4.84 mg/kg; values ranged from 4 mg/kg to 7.03 mg/kg. The off-site average concentration was 4.94 mg/kg. Summary statistics for nickel at these locations is presented in Table 4-12. For comparison, the U.S. Surface Soil concentration for nickel ranges from 5 mg/kg to 150 mg/kg.

Zinc

Two on-site locations (OC-13 and OC-19) were identified as CAT-2 for zinc. The average concentration at OC-13 was 102.2 mg/kg (values ranged from 43 mg/kg to 135 mg/kg), while the average concentration at OC-19 was 118.0 mg/kg (values ranged from 54.2 mg/kg to 196 mg/kg). One perimeter location (T-37) located near the guard house at base housing was identified as CAT-3 for zinc. The average concentration at T-37 was 29.1 mg/kg (values ranged from 20 mg/kg to 43.9 mg/kg). The off-site average concentration was 32.0 mg/kg. Summary statistics for zinc at this location are presented in Table 4-13. For comparison, the U.S. Surface Soil concentration for zinc ranged from 13 mg/kg to 300 mg/kg.

The *Water Conservation Plan for the Tonopah Test Range* complies with State Water Resources Division regulations requiring a water conservation plan for permitted water systems and major water users in Nevada (DOE 1992).

4.6.1 Production Well Monitoring

Production Well 6, which supplies drinking water to the Sandia Corporation Main Compound in Area 3, is routinely sampled for contaminants. All sampling is conducted in accordance with requirements set by the state (State of Nevada 1997). Analytes are sampled at different intervals as follows:

Analyte	Sampling frequency
Total Coliform	monthly
Nitrates and nitrites	annually
Dioxins	last sampled in 1999
Volatile organic compounds (VOCs) and Semi-VOCs (SVOCs)	last sampled in 1999
Copper and lead*	last sampled in 1999

NOTE: *Sampling is due in 2002

A complete chemical and radiological analysis of drinking water for the Nevada Test Site (NTS) is required by the State of Nevada every three years; this was last performed on April 8, 1999. Sampled parameters included, but were not limited to, nitrates, nitrites, VOCs, lead, copper, and arsenic.

Parallel Sampling by the Environmental Protection Agency (EPA)

The EPA also performs sampling on Production Well 6 for nitrate and nitrites every three years. In addition, the EPA provides a radiological analysis survey for the Long-Term Hydrologic Monitoring Program. Sampling sites are based on state specified locations (State of Nevada 1997) and are in accordance with the Safe Drinking Water Act (SDWA).

4.6 WATER MONITORING

Results for potable water and wastewater effluent sampling are presented below. The issue of storm water monitoring is also discussed.

4.6.2 Sewage System and Septic Tank Monitoring

Annual wastewater samples were taken in May 2000. Sandia Corporation conducts wastewater monitoring at the Area 3 monitoring station. There was one reportable release in 2000:

- A leak occurred from the secondary containment system of a 1,000-gal aboveground storage tank (AST) containing diesel. Corrective actions for the release were implemented and approved by the State of Nevada, Nevada Division of Environmental Protection (NDEP) on October 9, 2000. The corrective actions included a program of routine maintenance and inspection of secondary containment structures.

Sewage System

Sewage from Sandia Corporation's facilities in the Main Compound at Area 3 goes to the USAF facultative sewage lagoon. Westinghouse Government Services takes annual wastewater samples from Area 3 at the point wastewater leaves Sandia Corporation property and enters the USAF system.

The USAF holds the NPDES permit for its wastewater discharges. The USAF takes quarterly samples from the headwater end of the lagoon. In the past, Sandia Corporation provided quarterly sampling results to the USAF for inclusion into their USAF Discharge Monitoring Report (DMR); however, the NPDES permit was modified in 1997 and no longer stipulates the requirement of quarterly data from Sandia Corporation. Therefore, Sandia Corporation now only provides annual sample results to the USAF.

Westinghouse Government Services collects 48-hour composite wastewater samples on an annual basis and has the following parameters analyzed:

- Total cyanide (Sandia Corporation does not use cyanide containing compounds at TTR);

- pH (potential of hydrogen [acidity]) and non-filtered residue;
- Phenolics (Sandia Corporation does not use phenol-containing compounds at TTR);
- Chemical oxygen demand (COD);
- VOCs;
- SVOCs;
- Metals (cadmium, chromium, copper, nickel, silver, zinc, lead, selenium, and mercury);
- Total recoverable petroleum hydrocarbons (TRPH);
- Oil and grease; and
- Tritium, gamma spectroscopy, gross alpha, and gross beta.

All analytical results for wastewater sampled at Area 3 were within regulatory limits in 2000. Analytical results can be obtained from Westinghouse Government Services.

Septic Tank Systems

Septic tank systems are sampled, as needed. There are six septic systems located on-site, which are owned by Sandia Corporation at TTR. These six active septic tanks are used in remote locations and are maintained by the TTR facilities group. The sewage from these locations flows into septic tanks and associated drain fields. None of these systems required maintenance, sampling, or pumping in 2000. All other remaining septic systems have been closed or are undergoing closure and are being addressed by the ER Project.

4.6.3 Storm Water Monitoring

Currently, Sandia Corporation has no requirement to perform storm water monitoring at TTR. All storm water issues and monitoring is managed by the USAF.



Chapter 5

Air Quality Surveillance and Emissions Monitoring

Air quality compliance at the Tonopah Test Range (TTR) is met by adherence to specific permit conditions and compliance with local, state, and federal air regulations. Ambient air quality monitoring is not currently required at TTR. Ambient air monitoring was last conducted in 1996 to ascertain the level of radiological constituents in the air as discussed below.

5.1 RADIOLOGICAL AIR MONITORING

Operations by Sandia Corporation at TTR do not involve activities that release radioactive emissions from either point sources (stacks and vents) or diffuse sources such as outdoor testing. However, diffuse radiological emissions are produced from the re-suspension of americium and plutonium present at the Clean Slate Environmental Restoration (ER) sites. Other ER sites with minor radiological contamination, such as depleted uranium (DU), do not produce significant air emission sources from re-suspension.

National Emission Standards for Hazardous Air Pollutants (NESHAP)

NESHAP, 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," has set a maximum of 10 mrem/yr for all combined air emission pathway sources from any U.S. Department of Energy (DOE) facility. Although the dose calculated from the Clean Slate sites is many times less than this standard, there was a question of whether the site would require continuous radiological air monitoring.

The 1995 NESHAP report for TTR reported a calculated effective dose equivalent (EDE) to the maximally exposed individual (MEI) of 1.1 mrem/yr as a result of diffuse emissions from the Clean Slate sites (SNL 1996). Because the U.S. Environmental Protection Agency (EPA) requires continuous air monitoring for any radionuclide source that contributes a dose in excess of 0.1 mrem/yr to the MEI, Sandia Corporation instituted continuous air monitoring at the site for one year, from February 22, 1996 to February 25, 1997. The monitoring site was chosen at the TTR Airport, the location of the highest calculated dose for a member of the public. This site selection is discussed in the 1996 NESHAP report (SNL 1997). The dose assessment result from the continuous monitoring was 0.024 mrem/yr. This was about four times less than the 0.1 mrem/yr threshold cutoff for which continuous monitoring would be required by the EPA. The average air concentration in curies per cubic meter (Ci/m³) were measured as follows:

Americium-241	4.1×10^{-18} Ci/m ³
Plutonium-238	1.6×10^{-18} Ci/m ³
Plutonium-239/240	9.5×10^{-19} Ci/m ³

Although an annual calculated dose assessment is not required for the site, Sandia Corporation continues to produce a annual NESHAP report for TTR (SNL 2001a). The results from the 1996 to 1997 monitoring will continue to be used for as long as there is no change in the status of the Clean Slate sites. Table 5-1 summarizes these dose assessment results. Future TTR activities are not expected to change. However, if new sources or modifications to the existing sources are anticipated, they will be evaluated for NESHAP applicability.

5.2 NON-RADIOLOGICAL AIR EMISSIONS

sources include generators, paint booths, and various combustion sources. In 2000, the total emissions reported to the State of Nevada were 2.92 standard tons (Table 5-2).

The TTR Class II Air Quality Permit requires emission reports from nonradionuclide sources. At TTR these

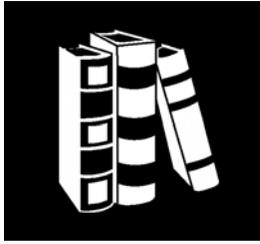
TABLE 5-1. Calculated Dose Assessment Results for On-site Receptor

Dose to Receptor	Location	1997 Measured Dose*	NESHAP Standard	Natural Background
On-site Receptor (EDE to the MEI)	Airport TTR Area	0.024 mrem/yr (0.00024 mSv/yr)	10 mrem/yr (0.1 mSv/yr)	250 ¹

NOTE: *Dose calculated from continuous monitoring February 1996 to February 1997.
 EDE = effective dose equivalent
 MEI = maximally exposed individual
 mSv/yr = millisievert per year
 TTR = Tonopah Test Range

TABLE 5-2. Emissions From TTR Sources in 2000

Pollutant	Standard Tons
Hazardous air pollutants (HAPs)	0.05
Nitrous oxides (NO _x)	2.49
Particulate matter (PM)	0.18
Sulfur dioxide (SO ₂)	0.16
Volatile Organic Compounds (VOCs)	0.04
Total	2.92



Chapter 6

References

- Brookins 1992** Brookins, D., "Background Radiation in the Albuquerque, New Mexico, U.S.A., Area," in *Environmental Geology and Water Science*, Vol. 19, No. 1, pp. 11-15 (1992).
- DOC 2001** U.S. Department of Commerce, U.S. Census Bureau website at <<http://www.census.gov/>> (2001).
- DoD/DOE/
State of NV
1996** U.S. Department of Defense, U.S. Department of Energy, and Nevada Department of Conservation and Natural Resources, *Federal Facility Agreement and Consent Order (FFACO)*. State of Nevada Department of Conservation and Natural Resources Division of Environmental Protection and the U.S. DOE and the U.S. DoD in the Matter of Federal Facility Agreement and Consent Order (March 15, 1996). Available on the Web at: <http://ndep.state.nv.us/boff/agree.htm>
- DOE 1996a** DOE Order 231.1 (See Orders Section).
- DOE 1996b** U.S. Department of Energy, *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS 0243. DOE, Nevada Operations Office, Las Vegas, NV (August 1996).
- DOE 1994** U.S. Department of Energy, *Memorandum of Agreement Between the Nevada Operation's Office and the Albuquerque Operations Office*, DE-GM08-98NV13555 (Appendix C, *Tonopah Test Range*, signed October 1997). U.S. Department of Energy, Albuquerque, NM and Las Vegas, NV (1994).
- DOE 1992** U.S. Department of Energy, *Water Conservation Plan for the Tonopah Test Range*, R4809. DOE, Nevada Operations Office, Las Vegas, NV (1992).
- DOE 1990** DOE Order 5400.1 (See Orders Section).
- DRI 1999** Desert Research Institute (DRI), *Community Radiation Monitoring Program Annual Report 1999*. DRI, Las Vegas, NV (1999).
- DRI 1991** Desert Research Institute, *Special Nevada Report*, DOE/NV/10715-T1. Prepared by Science Applications International Corporation (SAIC) for the Department of the Air Force (September 23, 1991).
- Dunaway
and White,
1974** Dunaway, P.B. and M.G. White, *The Dynamics of Plutonium in Desert Environments, Nevada Applied Ecology Group Progress Report*, NVO-142. U.S. Atomic Energy Commission, Nevada Operations Office, Las Vegas, NV (1974).
- E&E 1989** Ecology and Environment, Inc., *Federal Facility Preliminary Assessment Review*, EPA Region IX, F9-8903-021, NV3570090016. Ecology and Environment, Inc., San Francisco, CA (1989).
- EG&G 1979a** Edgerton, Germeshausen & Grier Corporation, *Status of Endangered and Threatened Plant Species on Tonopah Test Range - A Survey*, EGG-1183-2387. EG&G, Las Vegas, NV (1979).

- EG&G 1995** Edgerton, Germeshausen & Grier Corporation, *Aerial Radiological Survey of the Tonopah Test Range Including Clean Slate 1, 2, 3, Roller Coaster, Decontamination Area, Cactus Springs Ranch Target Areas, Central Nevada*, EGG-11265-1145. EG&G Energy Measurements, Inc., Las Vegas, NV (1995).
- EPA 1985** U.S. Environmental Protection Agency, *Interim Off-site Monitoring Report Nevada Test Site and Other Test Areas, Second Quarter 1985*, Report Number NRD 85-08. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Monitoring Systems Laboratory, Las Vegas, NV (1985).
- EPA 1999** U.S. Environmental Protection Agency, *Off-site Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1997*, EPA/402-R-98-013, U.S. Environmental Protection Agency, Las Vegas, NV (1999).
- ERDA 1975** U.S. Energy Research and Development Administration, *Environmental Assessment, Tonopah Test Range*, EIA/MA/76-2. ERDA (1975).
- Essington and Fowler 1976** Essington, E. H., and E. B. Fowler, "Distribution of Transuranic Nuclides in Soils," a review in *Transuranics in Natural Environments*, Report NVO-178. U.S. Energy Research and Development Administration, Las Vegas, NV (1976).
- Gilbert et al. 1975** Gilbert, R. O., et al., "Statistical Analysis of $^{239-240}\text{Pu}$ and ^{241}Am Contamination of Soil and Vegetation on NAEG Study Sites," in *The Radioecology of Plutonium and Other Transuranics in Desert Environments*, Report NVO-153. U.S. Energy Research and Development Administration, Las Vegas, NV (1975).
- IT 1996** IT Corporation, *Sampling and Analysis Plan for Clean Slate 1*. IT Corporation (September 1996).
- IT 1993** IT Corporation, *Analytical Results for Tonopah Test Range, Transformer Oil Samples, Collected July 16-18, 1993*. IT Corporation, Albuquerque, NM (September 1993).
- Kabata-Pendias and Pendias, 1992** Kabata-Pendias and Pendias, 1992, *Trace Elements in Soils and Plants*, 2nd. Ed. CRC Press, Inc., Boca Raton, Florida (1992).
- Leavitt 1980** Leavitt, V., *Soil Profiles of Mounds on Plutonium-Contaminated Areas of the Nevada Test Range Complex*. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Las Vegas, NV (1980).
- Leavitt 1976** Leavitt, V., "Soil Surveys of Five Plutonium-Contaminated Areas on the Test Range Complex in Nevada," in *Nevada Applied Ecology Group Procedures Handbook for Environmental Transuranics*, Report NVO-166, Volume 1. National Environmental Research Center, Las Vegas, NV (1976).
- Romney et al. 1975** Romney, E. M., et al., " $^{239-240}\text{Pu}$ and ^{241}Am Contamination of Vegetation in Aged Plutonium Fallout Areas," in *The Radioecology of Plutonium and Other Transuranics in Desert Environments*, Report NVO-153. U.S. Energy Research and Development Administration, Las Vegas, NV (1975).
- Schaeffer 1970** Schaeffer, J. R., *Climatology of Tonopah Test Range, Nevada 1961-1969*, SC-TM-70-0215. Sandia National Laboratories, Albuquerque, NM (1970).

- Shyr, Herrera, Haaker 1998** Shyr, L.J., H. Herrera, R. Haaker, *The Role of Data Analysis in Sampling Design of Environmental Monitoring*, SAND98-0612. Sandia National Laboratories, Albuquerque, NM (March 1998).
- Sinnock 1982** Sinnock, S., *Geology of the Nevada Test Site and Nearby Areas - Southern Nevada*, SAND82-2207. Sandia National Laboratories, Albuquerque, NM (1982).
- SNL 2001a** Sandia National Laboratories, *NESHAP Annual Report for CY 2000, Sandia National Laboratories, Nevada*, internal doc # 75-1021-5. Sandia National Laboratories, Albuquerque, NM (June 2001).
- SNL 2001b** Sandia National Laboratories, *Tonopah Test Range Data Analysis in Support of the Annual Site Environmental Report, 2000*. Sandia National Laboratories, Albuquerque, NM (July 2001).
- SNL 2000** Sandia National Laboratories, *1999 Hazardous Waste Biennial Report for Sandia National Laboratories/New Mexico and Sandia National Laboratories/Tonopah Test Range*, Sandia National Laboratories, Albuquerque, New Mexico (2000).
- SNL 1999** Sandia National Laboratories, *Spill Prevention Control and Countermeasures (SPCC) Plan for SNL Tonopah Test Range*, Plan 90-12, Rev. 4. Sandia National Laboratories, Albuquerque, NM (October 1999).
- SNL 1997** Sandia National Laboratories, (1) *NESHAP Annual Report for CY 1996 (EPA Summary)* and (2) *Radiological Dose Calculations and Supplemental Dose Assessment Data for NESHAP Compliance for Sandia National Laboratories, Nevada, CY 1996*. Sandia National Laboratories, Albuquerque, NM (1997).
- SNL 1996** Sandia National Laboratories, (1) *NESHAP Annual Report for CY 1995 (EPA Summary)* and (2) *Radiological Dose Calculations and Supplemental Dose Assessment Data for NESHAP Compliance for Sandia National Laboratories, Nevada, CY 1995*. Sandia National Laboratories, Albuquerque, NM (1996).
- SNL 1993** Culp, T. and Howard, D., *1992 Environmental Monitoring Report, Tonopah Test Range, Tonopah, Nevada*, SAND 93-1449. Sandia National Laboratories, Albuquerque, NM (1993).
- State of Nevada 1997** State of Nevada, *State of Nevada Bureau of Health Protection Services Vulnerability Assessment Contamination Monitoring Waiver*. State of Nevada, (Sampling protocols for water quality, expiration date 2010) (October 21, 1997).
- Tamura 1977** Tamura, T., "Plutonium Distribution in a Desert Pavement - Desert Mound Soil System in Area 11," in *Environmental Plutonium on the Nevada Test Site and Environs*, Report NVO-171. U.S. Energy Research and Development Administration, Las Vegas, NV (1977).
- Tamura 1976** Tamura, T., "Plutonium Association in Soils," in *Transuranics in Natural Environments*, Report NVO-178. U.S. Energy Research and Development Administration, Las Vegas, NV (1976).
- Tamura 1975** Tamura, T., "Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site," in *The Radioecology of Plutonium and Other Transuranics in Desert Environments*, Report NVO-153. U.S. Energy Research and Development Administration, Las Vegas, NV (1975).

USAF 1978 United States Air Force, *Final Environmental Impact Statement, Proposed Public Land Withdrawal, Nellis Air Force Bombing Range: Nye, Clark, and Lincoln Counties, Nevada*. Department of the Air Force, Washington, DC (1978).

WRCC 2001 Western Regional Climate Center website: <http://www.wrcc.dri.edu/cemp/> (2001).

ACTS and STATUTES

American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C. § 1996)

Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. § 470aa)

Atomic Energy Act (AEA) of 1954 (42 U.S.C. § 2011 et seq.)

Clean Air Act (CAA) and CAA Amendments (CAAA) of 1990 (42 U.S.C. §7401)

Clean Water Act (CWA) of 1977 (the **Federal Water Pollution Control Act**)
(33 U.S.C. §1251)

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980
(42 U.S.C. §9601) Amended by the Superfund Amendments and Reauthorization Act (SARA)

Emergency Planning and Community Right to Know Act (EPCRA) of 1986 (42 U.S.C. §11001 et seq.)

Endangered Species Act (ESA) (16 U.S.C. §1531 et seq.)

Federal Facility Compliance Act (FFCA) of 1992 (42 U.S.C. § 6961)

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. §136).

National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. §4321).

National Historic Preservation Act of 1966 (16 U.S.C. §470).

Pollution Prevention Act of 1990 (42 U.S.C. §13101 et seq.)

Resource Conservation and Recovery Act (RCRA) of 1976 (42 U.S.C. §6901 et seq.)

Safe Drinking Water Act (SDWA) (42 U.S.C §300f).

Superfund Amendments and Reauthorization Act (SARA) of 1986 (see CERCLA)

Toxic Substances Control Act (TSCA) of 1976 (15 U.S.C. §2601 et seq.).

NOTE: U.S.C = United States Code

CODE OF FEDERAL REGULATIONS

10 CFR 1021	"National Environmental Policy Act Implementing Procedures"
40 CFR 61	"National Emission Standards for Hazardous Air Pollutants (NESHAP)"
40 CFR 110	"Discharge of Oil"
40 CFR 112	"Oil Pollution Prevention"
40 CFR 141.26	"Monitoring Frequency for Radioactivity in Community Water Systems"
40 CFR 270	"EPA Administered Permit Programs: The Hazardous Waste Permit Program"
40 CFR 280	"Technical Standards and Corrective Action Requirements for Owners and Operations of Underground Storage Tanks"

DOE and EXECUTIVE ORDERS

- DOE 2000** U.S. Department of Energy, *National Environmental Policy Act Compliance Program*, DOE Order 451.1B. U.S. Department of Energy, Washington, DC (October 26, 2000).
- DOE 1996a** U.S. Department of Energy, *Environment, Safety, and Health Reporting*, DOE Order 231.1, Change 2. U.S. Department of Energy, Washington, DC (November 7, 1996).
- DOE 1990** U.S. Department of Energy, *General Environmental Protection Program*, DOE Order 5400.1, Change 1. DOE, Washington, DC (June 29, 1990).
- EO 11990** *Protection of Wetlands* (May 24, 1977).
- EO 11988** *Floodplain Management* (May 24, 1977).

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APPENDIX A

**STATE OF NEVADA
ENVIRONMENTAL REGULATIONS**

Nevada regulatory information can be found at the Nevada State Legislature website:

<http://www.leg.state.nv.us/>

A listing of the Nevada Administrative Code (NAC) can be found at:

<http://www.leg.state.nv.us/NAC/Index.htm>

TABLE A-1. State of Nevada Administrative Code (NAC) Applicable to the Tonopah Test Range (TTR)

Chapter 444, Sanitation	Applicable Sources or Activities
NAC 444.570 to 444.7499, "Solid Waste Disposal"	<ul style="list-style-type: none"> • Disposal of construction debris • Disposal of routine non-hazardous solid wastes • Disposal of septic sludge
NAC 444A.005 to 444A.470, "Programs for Recycling"	<ul style="list-style-type: none"> • Recyclable materials including waste tires
Chapter 445A, Water Controls	
NAC 445A.070 to 445A.348, "Water Pollution Control"	<ul style="list-style-type: none"> • Septic tanks • Surface water runoff
NAC 445A.450 to 445 A. 6731, "Public Water Systems"	<ul style="list-style-type: none"> • Production well sampling
Chapter 445B, Air Controls	
NAC 445B.001 to 445B.395, "Air Pollution"	<ul style="list-style-type: none"> • Open burning • Hazardous air pollutants from stacks and vents • Disturbance of soils during construction (particulate matter)
NAC 445B.400 to 445B.774, "Emissions From Engines"	<ul style="list-style-type: none"> • Generators • Mobile sources
Chapter 504, Wildlife Mangement and Propagation*	
NAC 504.001 to 504.340, "Wildlife Management Areas" NAC 504.510 to 504.550, "Alteration of Stream System or Watershed"	<ul style="list-style-type: none"> • Road construction • Construction activities
NAC 504.800 to 504.865, "Preservation of Wild Horses"**	<ul style="list-style-type: none"> • General activities on the range in wild horse areas
Chapter 534, Underground Water and Wells	
NAC 534.010 to 534.450, "Underground Water and Wells"	<ul style="list-style-type: none"> • Drilling, operation, and abandonment of wells

NOTE: *This law provides protection to endangered, threatened, and sensitive species.

**Two wild horse units encompass areas within the Nellis Air Force Range:

"Unit 252: That portion of Nye County and those portions of the Nellis Air Force Range as authorized by the United States Department of Defense."

"Unit 253: That portion of Nye County ... including those portions of the Nellis Air Force Range as authorized by the United States Department of Defense and the Nevada Test Site as authorized by the United States Department of Energy."

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APPENDIX B
TERRESTRIAL SURVEILLANCE RESULTS
AND
SAMPLING LOCATION MAPS



Target Lake at Tonopah Test Range (1960s)

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TABLE B-1a. Radiological Results for Off-site Soil Sampling Locations, 2000

Location	Analyte	Units	Result	Error	MDA
B-01	Americium-241	pCi/g	0.0044	0.064	0.0217
	Cesium-137	pCi/g	0.143	0.0323	0.00659
	Potassium-40	pCi/g	25.4	2.58	0.0914
	Uranium-235	pCi/g	0.0264	0.128	0.0478
	Uranium-238	pCi/g	1.47	0.943	0.197
	Total Uranium	mg/kg	0.494	-999	0.0018
B-02	Americium-241	pCi/g	-0.00348	0.0788	0.0286
	Cesium-137	pCi/g	0.93	0.114	0.00817
	Potassium-40	pCi/g	30.2	3.36	0.114
	Uranium-235	pCi/g	0.0515	0.131	0.0603
	Uranium-238	pCi/g	0.955	1.03	0.258
	Total Uranium	mg/kg	1.44	-999	0.0018
B-03	Americium-241	pCi/g	-0.0533	0.0787	0.0284
	Cesium-137	pCi/g	0.0183	0.0251	0.00838
	Potassium-40	pCi/g	30	3.13	0.116
	Uranium-235	pCi/g	0.18	0.144	0.0612
	Uranium-238	pCi/g	1.35	1.01	0.256
	Total Uranium	mg/kg	0.944	-999	0.0018
B-04	Americium-241	pCi/g	-0.00843	0.0808	0.0289
	Cesium-137	pCi/g	0.166	0.0341	0.00701
	Potassium-40	pCi/g	31	3.34	0.0982
	Uranium-235	pCi/g	0.141	0.135	0.0521
	Uranium-238	pCi/g	1.58	1.19	0.251
	Total Uranium	mg/kg	0.564	-999	0.0018
B-05	Americium-241	pCi/g	0.0533	0.103	0.0305
	Cesium-137	pCi/g	0.431	0.0597	0.00731
	Potassium-40	pCi/g	28	3.2	0.102
	Uranium-235	pCi/g	0.11	0.0964	0.0432
	Uranium-238	pCi/g	1.93	1.6	0.257
	Total Uranium	mg/kg	0.625	-999	0.0018
B-06	Americium-241	pCi/g	0	0.0348	0.0159
	Cesium-137	pCi/g	0.588	0.0893	0.00825
	Potassium-40	pCi/g	26.8	2.57	0.113
	Uranium-235	pCi/g	0.0906	0.146	0.0566
	Uranium-238	pCi/g	1.62	0.699	0.157
	Total Uranium	mg/kg	0.511	-999	0.0018
B-07	Americium-241	pCi/g	0.0247	0.0879	0.0242
	Cesium-137	pCi/g	0.192	0.0487	0.00804
	Potassium-40	pCi/g	30.6	3.12	0.12
	Uranium-235	pCi/g	0.142	0.225	0.0497
	Uranium-238	pCi/g	0.798	1.3	0.277
	Total Uranium	mg/kg	0.494	-999	0.0018

NOTE: pCi/g = picocurie per gram
mg/kg = milligram per kilogram
MDA = minimum detectable activity

TABLE B-1a. Radiological Results for Off-site Soil Sampling Locations, 2000
(concluded)

Location	Analyte	Units	Result	Error	MDA
B-08	Americium-241	pCi/g	-0.0332	0.0927	0.025
	Cesium-137	pCi/g	0.215	0.0629	0.00838
	Potassium-40	pCi/g	31.9	3.34	0.125
	Uranium-235	pCi/g	0.0684	0.164	0.051
	Uranium-238	pCi/g	1.82	1.4	0.283
	Total Uranium	mg/kg	0.611	-999	0.0018
B-09	Americium-241	pCi/g	-0.0175	0.135	0.0331
	Cesium-137	pCi/g	0.129	0.0442	0.00874
	Potassium-40	pCi/g	29.2	3.45	0.132
	Uranium-235	pCi/g	0.211	0.127	0.054
	Uranium-238	pCi/g	1.48	1.62	0.358
	Total Uranium	mg/kg	0.625	-999	0.0018
B-10	Americium-241	pCi/g	-0.0231	0.11	0.0272
	Cesium-137	pCi/g	0.242	0.0492	0.00885
	Potassium-40	pCi/g	20.2	2.29	0.132
	Uranium-235	pCi/g	0.0615	0.133	0.0543
	Uranium-238	pCi/g	2.11	1.56	0.305
	Total Uranium	mg/kg	1.04	-999	0.0018
B-11	Americium-241	pCi/g	0.00286	0.105	0.0268
	Cesium-137	pCi/g	0.167	0.0407	0.00716
	Potassium-40	pCi/g	32.2	3.54	0.108
	Uranium-235	pCi/g	0.000148	0.145	0.0446
	Uranium-238	pCi/g	1.01	1.42	0.291
	Total Uranium	mg/kg	0.78	-999	0.0018
B-12	Americium-241	pCi/g	0.0335	0.113	0.0326
	Cesium-137	pCi/g	0.276	0.0542	0.0103
	Potassium-40	pCi/g	34.5	3.94	0.154
	Uranium-235	pCi/g	0.157	0.199	0.0636
	Uranium-238	pCi/g	0.178	1.42	0.367
	Total Uranium	mg/kg	0.79	-999	0.0018
B-13	Americium-241	pCi/g	0.0183	0.0506	0.0191
	Cesium-137	pCi/g	0.148	0.0331	0.00626
	Potassium-40	pCi/g	31.9	3.24	0.0906
	Uranium-235	pCi/g	0.154	0.17	0.0433
	Uranium-238	pCi/g	1.25	0.965	0.221
	Total Uranium	mg/kg	0.603	-999	0.0018
B-14	Americium-241	pCi/g	0.0215	0.0288	0.0152
	Cesium-137	pCi/g	0.2	0.0475	0.00892
	Potassium-40	pCi/g	31.4	3.09	0.133
	Uranium-235	pCi/g	0.124	0.104	0.052
	Uranium-238	pCi/g	0.875	0.624	0.189
	Total Uranium	mg/kg	0.601	-999	0.0018

NOTE: pCi/g = picocurie per gram
mg/kg = milligram per kilogram
MDA = minimum detectable activity

TABLE B-1b. Stable Metal Results for Off-site Soil Sampling Locations, 2000

Analyte	Units	Method Detection Limit	B-01	B-02	B-03	B-04	B-05	B-06	B-07
Aluminum	mg/kg	0.0615	5930	6270	4150	4180	7400	7210	4970
Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.463	0.0815	0.0815	0.0815
Arsenic	mg/kg	0.131	3.69	11	6.21	5.39	6.12	8.56	3.34
Barium	mg/kg	0.0465	104	112	68.8	87	111	180	129
Beryllium	mg/kg	0.0311	0.361	0.432	0.442	0.238	0.431	0.397	0.313
Cadmium	mg/kg	0.0382	0.171	0.184	0.0382	0.107	0.132	0.119	0.247
Chromium	mg/kg	0.0645	3.73	4.02	2.48	3.8	5.59	5.2	3.11
Cobalt	mg/kg	0.0555	4.02	5.27	2.55	2.09	3.78	4.03	2.56
Copper	mg/kg	0.1	5.81	9.41	3.53	6.66	10.8	12.1	6.01
Iron	mg/kg	1.14	6870	7170	5910	5720	7710	6890	5800
Lead	mg/kg	0.099	9.47	16.8	8.95	10.9	9.53	13.6	20.7
Magnesium	mg/kg	0.184	3100	3200	1970	2870	4590	3520	2490
Manganese	mg/kg	0.0885	398	438	212	227	292	325	327
Mercury	mg/kg	0.0152	0.00556	0.0198	0.0124	0.00936	0.0117	0.0102	0.00662
Nickel	mg/kg	0.072	5.05	5.21	2.67	3.17	5.69	4.79	3.18
Potassium	mg/kg	2.3	1870	1860	1190	1780	2780	3160	2780
Selenium	mg/kg	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146
Silver	mg/kg	0.101	0.101	0.762	0.101	0.685	0.101	0.101	0.101
Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205
Vanadium	mg/kg	0.074	10.8	13	12	10.1	15.4	14.9	7.27
Zinc	mg/kg	0.138	29.7	34.1	24.8	31.8	31.7	29.5	45.8

NOTE: mg/kg = milligram per kilogram

TABLE B-1b. Stable Metal Results for Off-site Soil Sampling Locations, 2000 (concluded)

Analyte	Units	Method Detection Limit	B-08	B-09	B-10	B-11	B-12	B-13	B-14
Aluminum	mg/kg	0.0615	4190	5060	5250	6270	4850	4350	4170
Antimony	mg/kg	0.0815	0.0815	0.0815	0.284	0.0815	0.0815	0.0815	0.0815
Arsenic	mg/kg	0.131	1.97	2.05	8.84	3.06	2.72	1.83	2.23
Barium	mg/kg	0.0465	154	109	255	121	135	85.8	87.7
Beryllium	mg/kg	0.0311	0.279	0.305	0.518	0.267	0.324	0.267	0.255
Cadmium	mg/kg	0.0382	0.0808	0.0382	0.584	0.0382	0.231	0.0382	0.0836
Chromium	mg/kg	0.0645	2.27	3.8	5.78	2.94	2.65	2.13	2.45
Cobalt	mg/kg	0.0555	2.12	2.63	4.4	2.43	2.37	1.47	1.57
Copper	mg/kg	0.1	7.21	6.07	15.2	3.55	4.32	2.44	2.82
Iron	mg/kg	1.14	5150	5970	7830	5760	5030	4080	4150
Lead	mg/kg	0.099	9.97	14.9	22.5	6.65	7.21	4.65	5.21
Magnesium	mg/kg	0.184	1530	1980	8520	3440	2080	1580	1550
Manganese	mg/kg	0.0885	409	206	417	277	385	132	122
Mercury	mg/kg	0.0152	0.00526	0.00699	0.0174	0.00433	0.00963	0.0152	0.00497
Nickel	mg/kg	0.072	2.05	3.56	15	3.19	2.64	1.83	2.03
Potassium	mg/kg	2.3	1730	2050	2120	2970	2820	2350	2100
Selenium	mg/kg	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146
Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205
Vanadium	mg/kg	0.074	8.58	9.46	22.7	10.5	7.22	6.66	6.67
Zinc	mg/kg	0.138	23.3	22.4	70.8	17.9	19.8	14.9	15

NOTE: mg/kg = milligram per kilogram

TABLE B-2a. Radiological Results for Perimeter Soil Sampling Locations, 2000

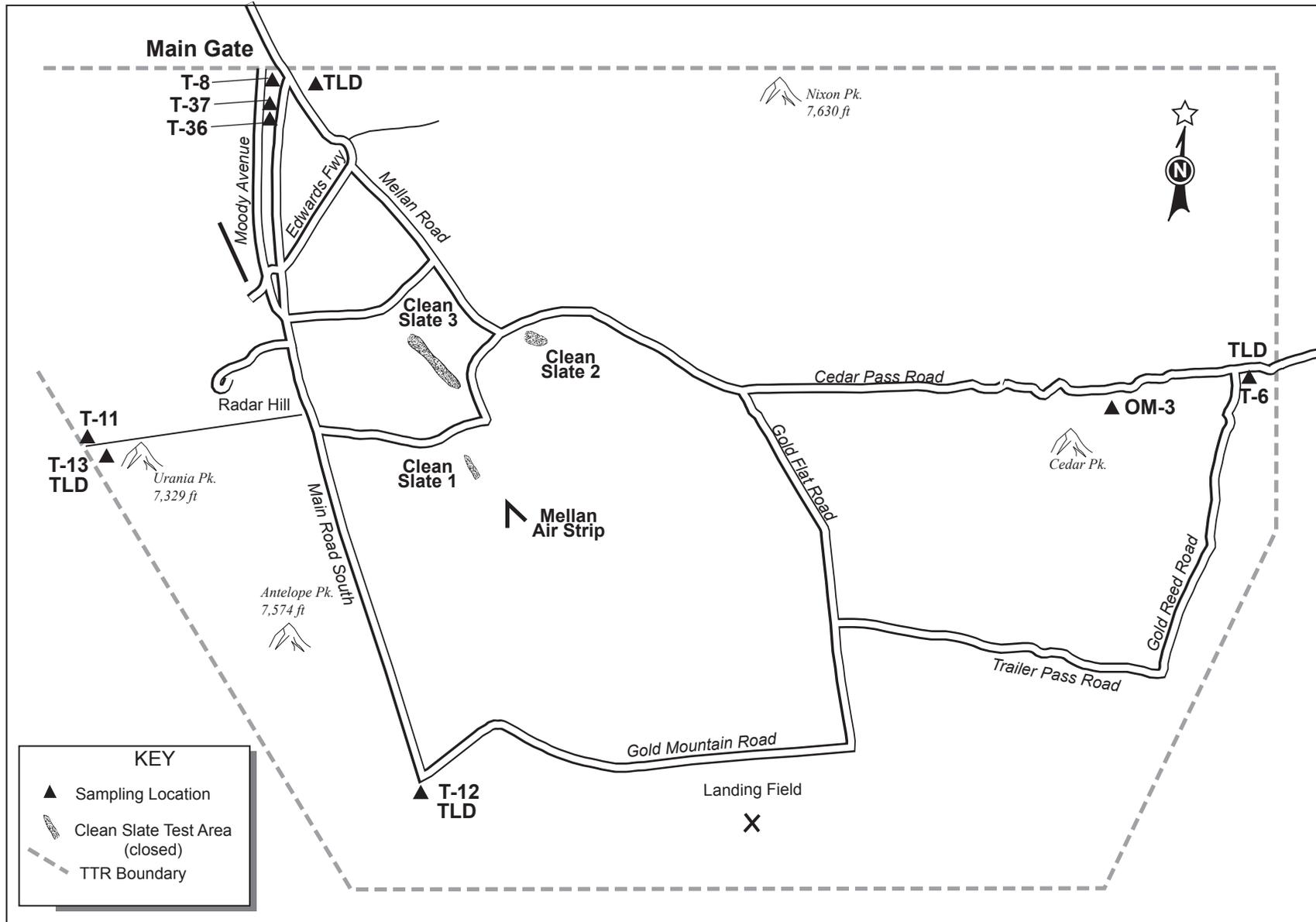
Location	Analyte	Units	Result	Error	MDA
OM-03	Americium-241	pCi/g	0.0367	0.0419	0.0203
	Cesium-137	pCi/g	0.44	0.0893	0.0102
	Potassium-40	pCi/g	32.9	3.2	0.137
	Total Uranium	mg/kg	0.519	--	0.0018
T-06	Americium-241	pCi/g	0.00393	0.0304	0.0166
	Cesium-137	pCi/g	0.113	0.0393	0.00882
	Potassium-40	pCi/g	31.6	3.07	0.122
	Total Uranium	mg/kg	0.589	--	0.0018
T-08	Americium-241	pCi/g	-0.0317	0.0947	0.025
	Cesium-137	pCi/g	0.0984	0.0474	0.00814
	Potassium-40	pCi/g	31.9	3.42	0.122
	Total Uranium	mg/kg	0.75	--	0.0018
T-11	Americium-241	pCi/g	0.0502	0.0643	0.0138
	Cesium-137	pCi/g	0.284	0.0549	0.00738
	Potassium-40	pCi/g	29.2	2.78	0.0983
	Total Uranium	mg/kg	0.798	--	0.0018
T-12	Americium-241	pCi/g	0.0263	0.117	0.034
	Cesium-137	pCi/g	0.345	0.0507	0.00736
	Potassium-40	pCi/g	35.3	3.94	0.0992
	Total Uranium	mg/kg	0.486	--	0.0018
T-13	Americium-241	pCi/g	-0.0505	0.189	0.026
	Cesium-137	pCi/g	0.182	0.0649	0.00929
	Potassium-40	pCi/g	22.5	2.3	0.123
	Total Uranium	mg/kg	0.504	--	0.0018
T-36	Americium-241	pCi/g	0.0176	0.147	0.0337
	Cesium-137	pCi/g	0.0265	0.0393	0.00781
	Potassium-40	pCi/g	31	3.57	0.117
	Total Uranium	mg/kg	0.769	--	0.0018
T-37	Americium-241	pCi/g	0.0225	0.0407	0.0153
	Cesium-137	pCi/g	0.0167	0.0342	0.00878
	Potassium-40	pCi/g	29.4	2.94	0.13
	Total Uranium	mg/kg	0.771	--	0.0018

NOTE: pCi/g = picocurie per gram
mg/kg = milligram per kilogram
MDA = minimum detectable activity

TABLE B-2b. Stable Metal Results for Perimeter Soil Sampling Locations, 2000

Analyte	Units	Minimum Detection Limit	OM-03	T-06	T-08	T-11	T-12	T-13	T-36	T-37
Aluminum	mg/kg	0.0615	5140	4790	2890	6350	6510	3370	3370	3910
Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815
Arsenic	mg/kg	0.131	2.17	2.48	1.9	4.33	6.87	5.5	1.53	2.12
Barium	mg/kg	0.0465	90.6	88.3	59.5	86.9	131	116	66.3	68.7
Beryllium	mg/kg	0.0311	0.343	0.364	0.199	0.788	0.471	0.495	0.214	0.26
Cadmium	mg/kg	0.0382	0.0382	0.117	0.0382	0.282	0.263	0.247	0.0382	0.0382
Chromium	mg/kg	0.0645	3.43	3.72	1.62	6.67	4.6	2.23	2.05	2.44
Cobalt	mg/kg	0.0555	2.54	2.6	1.27	6.42	3.99	3.04	1.39	1.61
Copper	mg/kg	0.1	4.02	4.09	2.25	20.9	4.75	4.07	2.76	3.14
Iron	mg/kg	1.14	4900	4550	3460	11700	7830	8010	3970	4310
Lead	mg/kg	0.099	7.57	8.91	3.3	13.1	11.8	15	3.15	3.59
Magnesium	mg/kg	0.184	2400	2010	1190	3130	3670	1290	1370	1730
Manganese	mg/kg	0.0885	292	290	115	665	494	394	111	120
Mercury	mg/kg	0.0152	0.0152	0.0152	0.00466	0.011	0.00917	0.0119	0.00469	0.00527
Nickel	mg/kg	0.072	3.32	3.27	1.63	9	5.06	2.37	1.74	2.18
Potassium	mg/kg	2.3	1960	1920	1590	1790	2940	1470	1490	1660
Selenium	mg/kg	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146
Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205
Vanadium	mg/kg	0.074	8.13	7.56	5.01	25.5	11.9	7.78	6.5	7.27
Zinc	mg/kg	0.138	22.1	30.6	14.9	62.9	33.7	35.2	13.9	43.9

NOTE: mg/kg = milligram per kilogram



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FIGURE B-2. Perimeter Soil Sampling Locations (Eight Locations)

TABLE B-3a. Radiological Results for South Plume Area Soil Sampling Locations, 2000

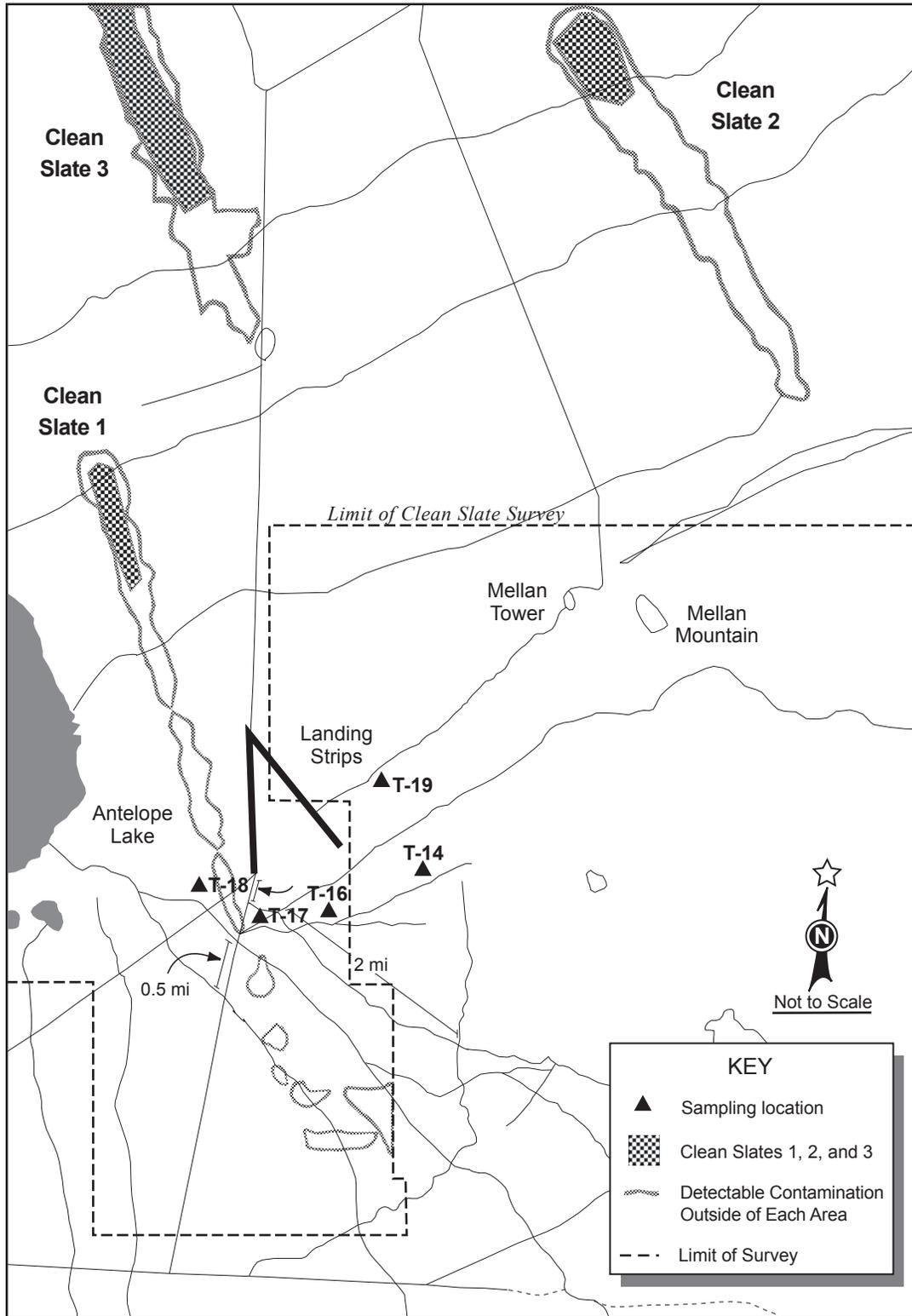
Location	Analyte	Units	Result	Error	MDA
T-14	Americium-241	pCi/g	0.109	0.115	0.0259
	Cesium-137	pCi/g	0.596	0.0881	0.00734
	Potassium-40	pCi/g	33.5	3.4	0.102
	Total Uranium	mg/kg	0.426	--	0.0018
T-16	Americium-241	pCi/g	0.134	0.11	0.0245
	Cesium-137	pCi/g	0.356	0.0506	0.00757
	Potassium-40	pCi/g	32.1	3.33	0.102
	Total Uranium	mg/kg	0.594	--	0.0018
T-17	Americium-241	pCi/g	-0.0434	0.0899	0.029
	Cesium-137	pCi/g	0.443	0.0589	0.00728
	Potassium-40	pCi/g	33.1	3.56	0.0989
	Total Uranium	mg/kg	0.488	--	0.0018
T-18	Americium-241	pCi/g	-0.00949	0.0912	0.0302
	Cesium-137	pCi/g	0.281	0.0444	0.00748
	Potassium-40	pCi/g	33.5	3.79	0.101
	Total Uranium	mg/kg	0.564	--	0.0018
T-19	Americium-241	pCi/g	0.155	0.049	0.0123
	Cesium-137	pCi/g	0.886	0.122	0.00674
	Potassium-40	pCi/g	31.4	2.95	0.0903
	Total Uranium	mg/kg	0.579	--	0.0018

NOTE: pCi/g = picocurie per gram
mg/kg = milligram per kilogram
MDA = minimum detectable activity

TABLE B-3b. Stable Metal Results for South Plume Area Soil Sampling Locations, 2000

Analyte	Units	MDL	T-14	T-16	T-17	T-18	T-19
Aluminum	mg/kg	0.0615	7820	7840	7230	7820	4500
Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815
Arsenic	mg/kg	0.131	2.53	2.53	2.16	3.24	3.37
Barium	mg/kg	0.0465	226	197	154	149	73.2
Beryllium	mg/kg	0.0311	0.41	0.427	0.415	0.481	0.338
Cadmium	mg/kg	0.0382	0.145	0.224	0.189	0.264	0.132
Chromium	mg/kg	0.0645	4.46	4.25	4.58	5.35	2.74
Cobalt	mg/kg	0.0555	3.53	3.44	3.38	3.67	2.14
Copper	mg/kg	0.1	5.71	5.65	5.81	6.57	3.56
Iron	mg/kg	1.14	6610	7200	7660	7750	5220
Lead	mg/kg	0.099	11.6	9.12	8.82	10.3	6.83
Magnesium	mg/kg	0.184	3270	3640	3490	4440	1970
Manganese	mg/kg	0.0885	512	461	356	433	251
Mercury	mg/kg	0.0152	0.0085	0.0113	0.00988	0.0108	0.00467
Nickel	mg/kg	0.072	4.71	5.59	4.79	5.48	2.68
Potassium	mg/kg	2.3	3830	5000	3890	3750	1880
Selenium	mg/kg	0.146	0.297	0.146	0.146	0.146	0.146
Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0.101
Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0.205
Vanadium	mg/kg	0.074	14.1	12.4	12.1	12.3	7.19
Zinc	mg/kg	0.138	27.4	28.6	28.7	30.9	18

NOTE: mg/kg = milligram per kilogram



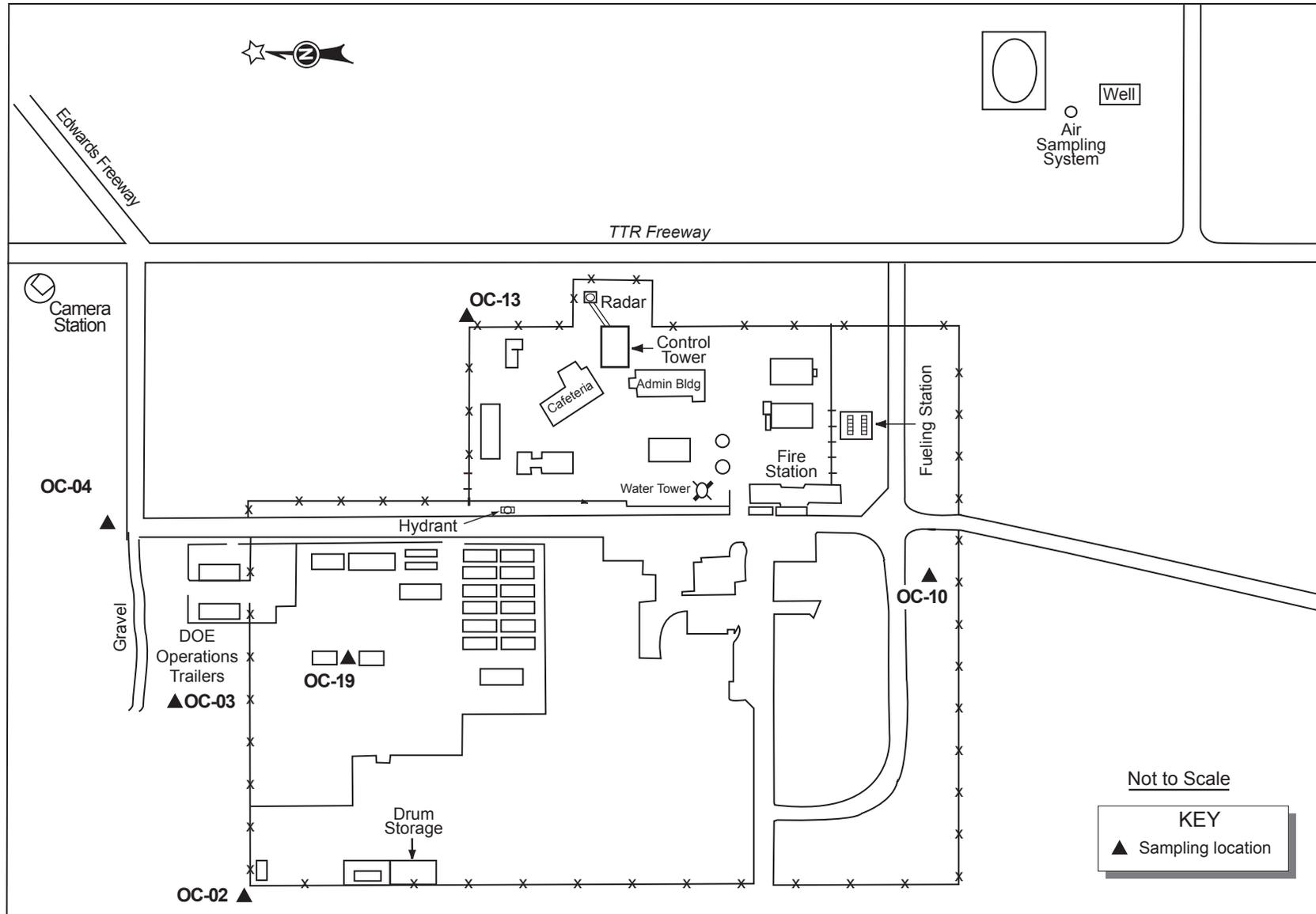
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FIGURE B-3. Soil Sampling Locations in the South Plume Area (Five Locations)

TABLE B-4a. Radiological Results for Range Operations Center Soil Sampling Locations, 2000

Location	Analyte	Units	Result	Error	MDA
OC-02	Americium-241	pCi/g	-0.00813	0.0404	0.0161
	Cesium-137	pCi/g	0.116	0.046	0.00888
	Potassium-40	pCi/g	30.4	3.03	0.129
	Total Uranium	mg/kg	0.708	-999	0.0018
OC-03	Americium-241	pCi/g	0.0101	0.0917	0.0233
	Cesium-137	pCi/g	0.0716	0.0283	0.00589
	Potassium-40	pCi/g	32.7	3.46	0.0854
	Total Uranium	mg/kg	0.655	-999	0.0018
OC-04	Americium-241	pCi/g	-0.0197	0.0554	0.0195
	Cesium-137	pCi/g	0.35	0.0613	0.0064
	Potassium-40	pCi/g	31	3.15	0.0927
	Total Uranium	mg/kg	0.643	-999	0.0018
OC-10	Americium-241	pCi/g	0.09	0.167	0.0416
	Cesium-137	pCi/g	0.0654	0.0452	0.00964
	Potassium-40	pCi/g	27.9	3.28	0.144
	Total Uranium	mg/kg	0.91	-999	0.0018
OC-13	Americium-241	pCi/g	0.0106	0.0461	0.0167
	Cesium-137	pCi/g	0.0335	0.0351	0.00954
	Potassium-40	pCi/g	30.8	3.11	0.141
	Total Uranium	mg/kg	0.698	-999	0.0018
OC-19	Americium-241	pCi/g	0.0292	0.142	0.0294
	Cesium-137	pCi/g	0.0124	0.0185	0.00788
	Potassium-40	pCi/g	35.4	3.9	0.119
	Total Uranium	mg/kg	0.726	-999	0.0018
OC-22	Americium-241	pCi/g	-0.063	0.111	0.0258
	Cesium-137	pCi/g	0.0334	0.0265	0.00812
	Potassium-40	pCi/g	33.1	3.74	0.122
	Total Uranium	mg/kg	0.919	-999	0.0018
OC-23	Americium-241	pCi/g	0.0564	0.155	0.0329
	Cesium-137	pCi/g	0.108	0.0466	0.0088
	Potassium-40	pCi/g	34.9	3.88	0.133
	Total Uranium	mg/kg	0.718	-999	0.0018

NOTE: pCi/g = picocurie per gram
mg/kg = milligram per kilogram
MDA = minimum detectable activity



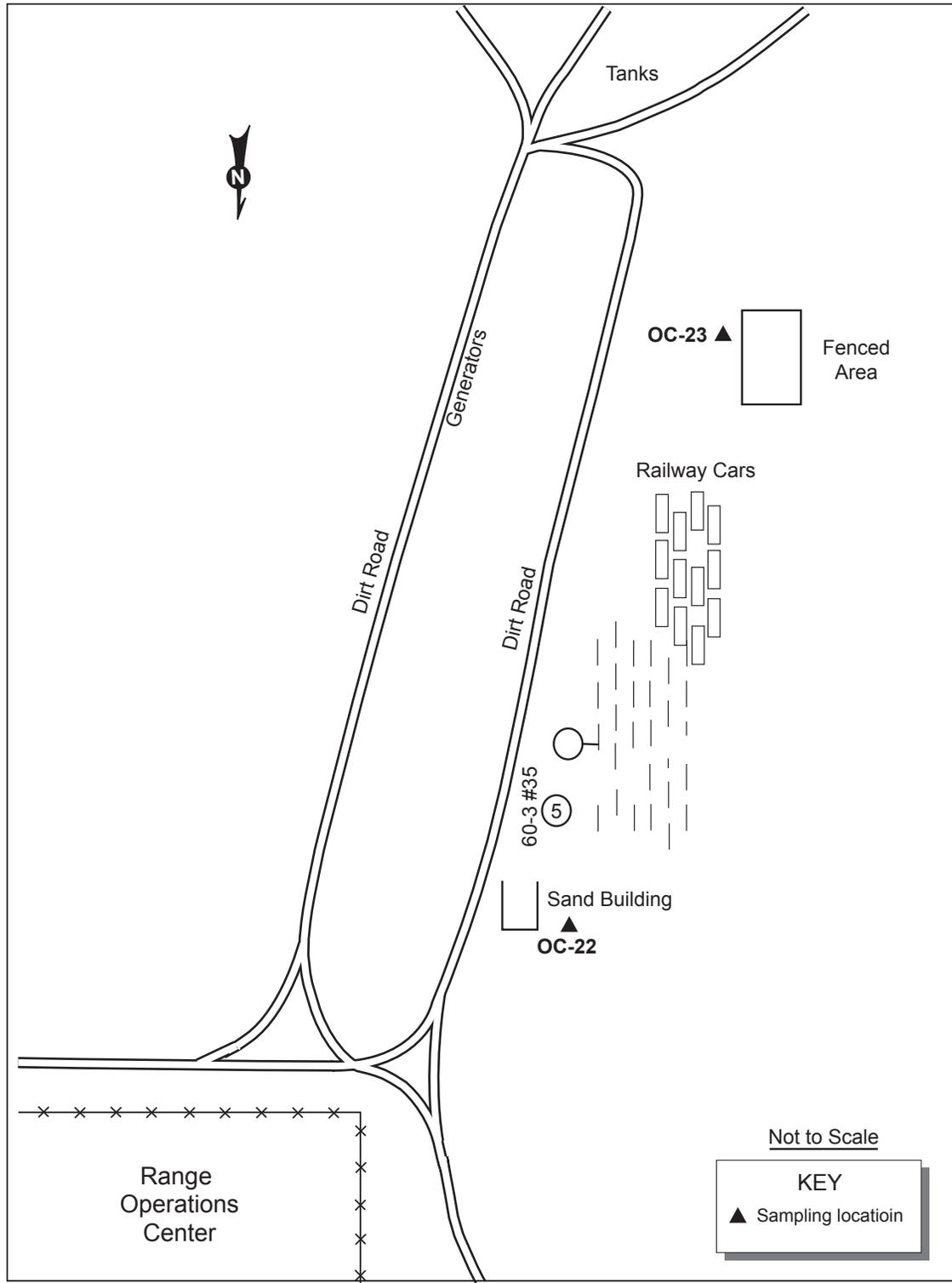
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FIGURE B-4a. Soil Sampling Locations in the Range Operations Center and Compound (Six Locations)

TABLE B-4b. Stable Metal Results for Range Operations Center Soil Sampling Locations, 2000

Analyte	Units	Minimum Detection Limit	OC-02	OC-03	OC-04	OC-10	OC-13	OC-19	OC-22	OC-23
Aluminum	mg/kg	0.0615	5230	4400	6040	6040	5860	4780	3310	5010
Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815	0.549	0.0815	0.0815
Arsenic	mg/kg	0.131	2.85	2.18	4.31	5.44	4.29	2.81	2.08	2.72
Barium	mg/kg	0.0465	339	76.9	134	112	107	92.8	65.2	115
Beryllium	mg/kg	0.0311	0.417	0.331	0.384	0.434	0.477	0.587	0.293	0.325
Cadmium	mg/kg	0.0382	0.146	0.17	0.117	0.375	0.0912	0.552	0.15	0.186
Chromium	mg/kg	0.0645	2.91	3.11	3.24	3.66	3.17	6.38	2.32	3.08
Cobalt	mg/kg	0.0555	4.06	2.54	4.58	2.84	2.96	2.97	2.17	3.14
Copper	mg/kg	0.1	6.26	4.42	6.22	5.41	4.43	4.58	3.33	5.92
Iron	mg/kg	1.14	6070	5230	8100	6370	6000	5490	5180	6470
Lead	mg/kg	0.099	30.8	9.03	7.73	13.7	7.49	20	6.11	7.49
Magnesium	mg/kg	0.184	2740	2100	3820	2750	2550	2470	1610	2810
Manganese	mg/kg	0.0885	1330	220	278	210	231	241	183	323
Mercury	mg/kg	0.0152	0.015	0.00509	0.00789	0.00864	0.0141	0.0152	0.0152	0.0231
Nickel	mg/kg	0.072	4.47	3.27	7.03	3.53	3.23	4.1	2.27	3.98
Potassium	mg/kg	2.3	2070	1970	2090	2180	2030	2120	1540	2810
Selenium	mg/kg	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146
Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205
Vanadium	mg/kg	0.074	18.7	9.22	13.2	12.6	12.4	10.9	7.06	10.8
Zinc	mg/kg	0.138	24.9	26.7	24.4	52.4	70.5	54.2	85	26.2

NOTE: mg/kg = milligram per kilogram



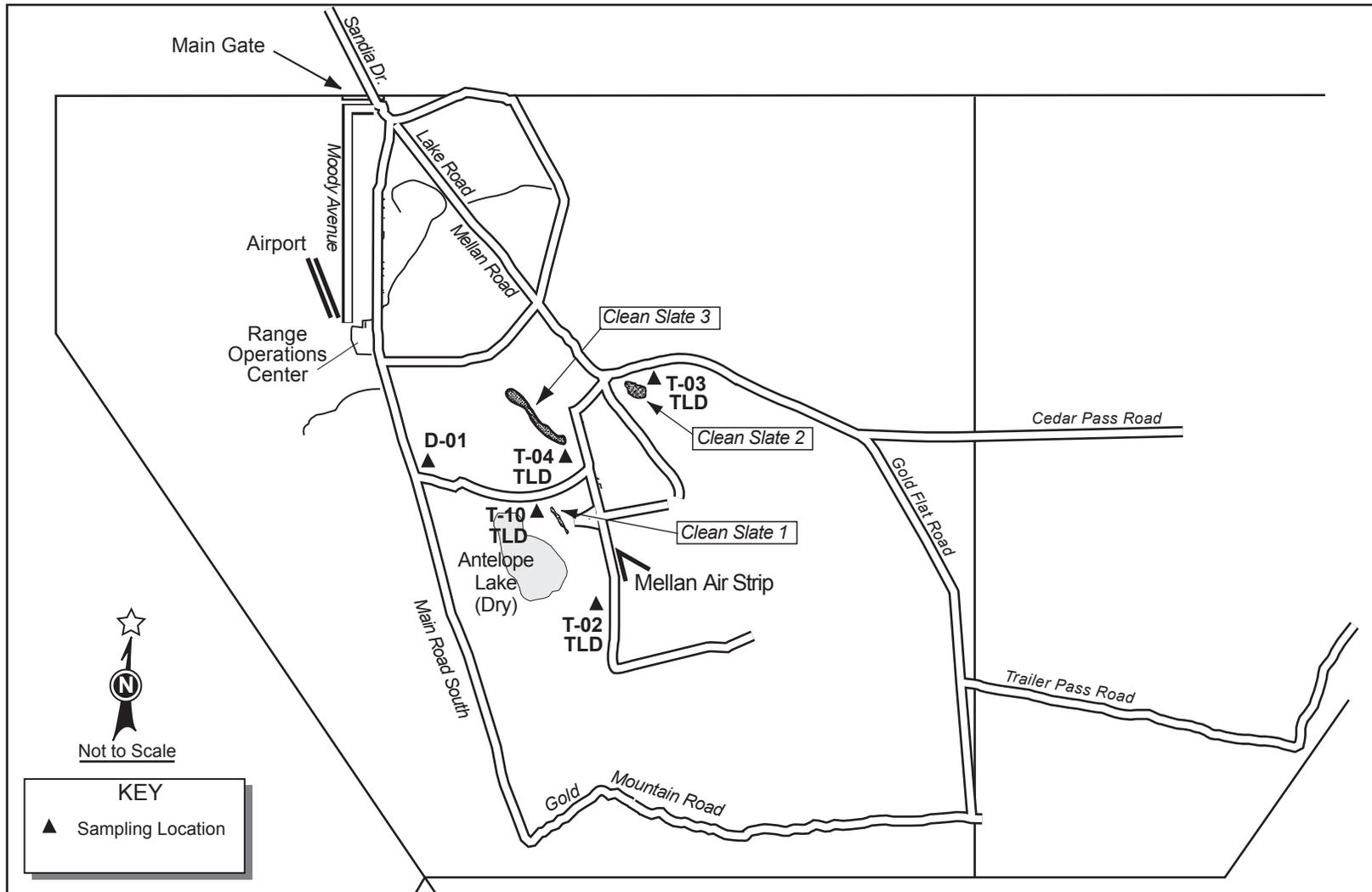
00_B-4b.ai

FIGURE B-4b. Soil Sampling Locations Around the Range Operations Center Storage Yard (Two Locations)

TABLE B-5a. Radiological Results for Various On-site Soil Sampling Locations, 2000

Location	Analyte	Units	Result	Error	MDA
D-01	Americium-241	pCi/g	3.58	0.66	0.0274
	Cesium-137	pCi/g	0.1	0.062	0.00951
	Potassium-40	pCi/g	22.1	2.28	0.13
	Total Uranium	mg/kg	0.543		0.0018
MH-03	Americium-241	pCi/g	0.163	0.173	0.0504
	Cesium-137	pCi/g	0.576	0.0925	0.0106
	Potassium-40	pCi/g	31.5	3.66	0.147
	Total Uranium	mg/kg	0.526		0.0018
MH-04	Americium-241	pCi/g	0.134	0.0956	0.0224
	Cesium-137	pCi/g	0.487	0.094	0.0116
	Potassium-40	pCi/g	33.4	3.33	0.16
	Total Uranium	mg/kg	0.619		0.0018
T-02	Americium-241	pCi/g	-0.162	0.205	0.0389
	Cesium-137	pCi/g	0.253	0.0917	0.0135
	Potassium-40	pCi/g	27.5	3.01	0.184
	Total Uranium	mg/kg	0.666		0.0018
T-03	Americium-241	pCi/g	-0.0282	0.102	0.0296
	Cesium-137	pCi/g	0.358	0.0717	0.00874
	Potassium-40	pCi/g	30.7	3.27	0.121
	Total Uranium	mg/kg	0.687		0.0018
T-04	Americium-241	pCi/g	-0.0097	0.12	0.0367
	Cesium-137	pCi/g	0.338	0.0591	0.0105
	Potassium-40	pCi/g	36	4.07	0.146
	Total Uranium	mg/kg	0.634		0.0018
T-10	Americium-241	pCi/g	0.0526	0.1	0.0347
	Cesium-137	pCi/g	0.157	0.0421	0.0105
	Potassium-40	pCi/g	34.2	3.57	0.146
	Total Uranium	mg/kg	0.661		0.0018
T-20	Americium-241	pCi/g	-0.104	0.171	0.0341
	Cesium-137	pCi/g	0.176	0.0492	0.00788
	Potassium-40	pCi/g	34.1	3.9	0.118
	Total Uranium	mg/kg	0.626		0.0018

NOTE: pCi/g = picocurie per gram
mg/kg = milligram per kilogram
MDA = minimum detectable activity



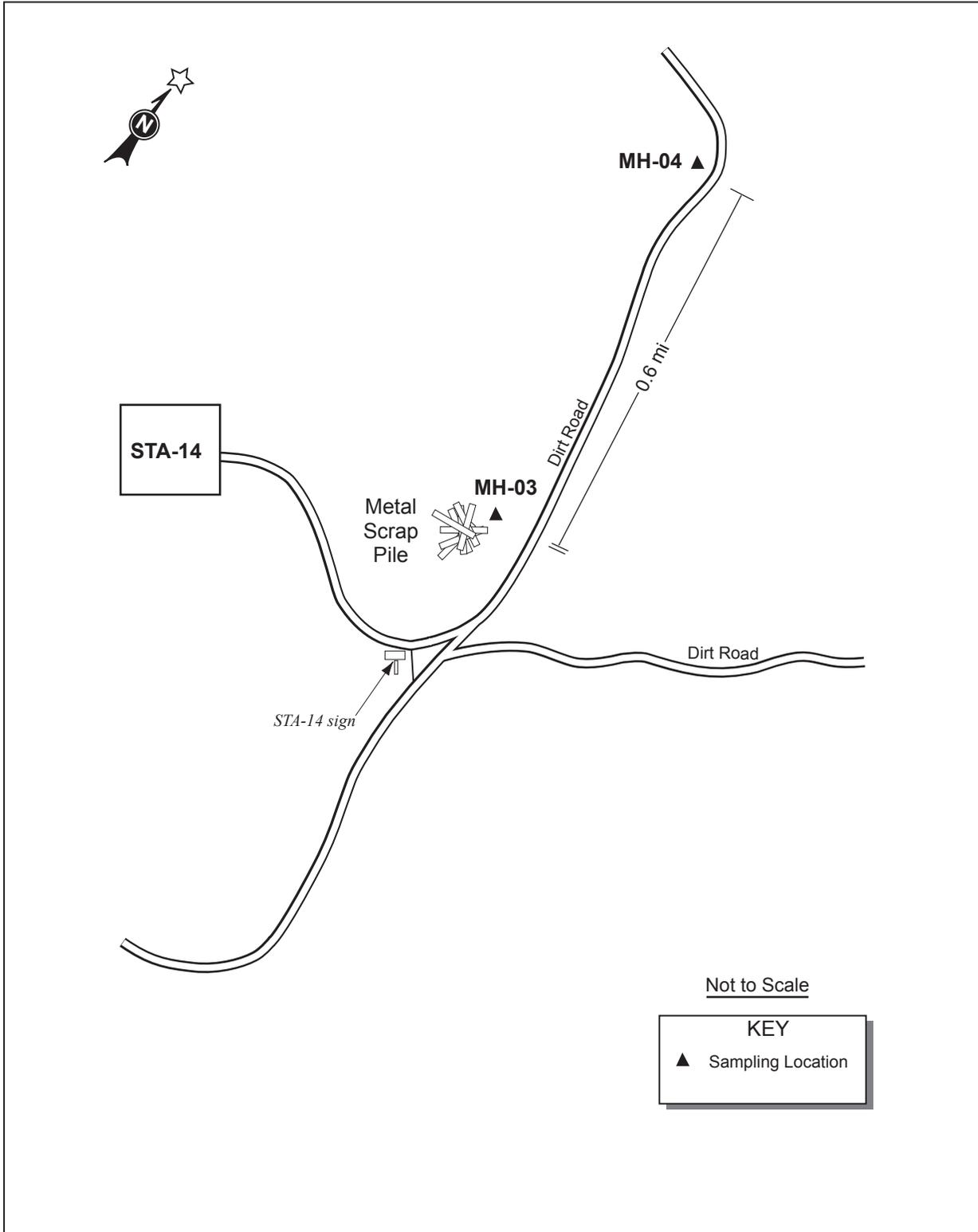
00_B-5a.ai

FIGURE B-5a. Various Onsite Soil Sampling Locations (Five Locations)

TABLE B-5b. Stable Metal Results for Various On-site Soil Sampling Locations, 2000

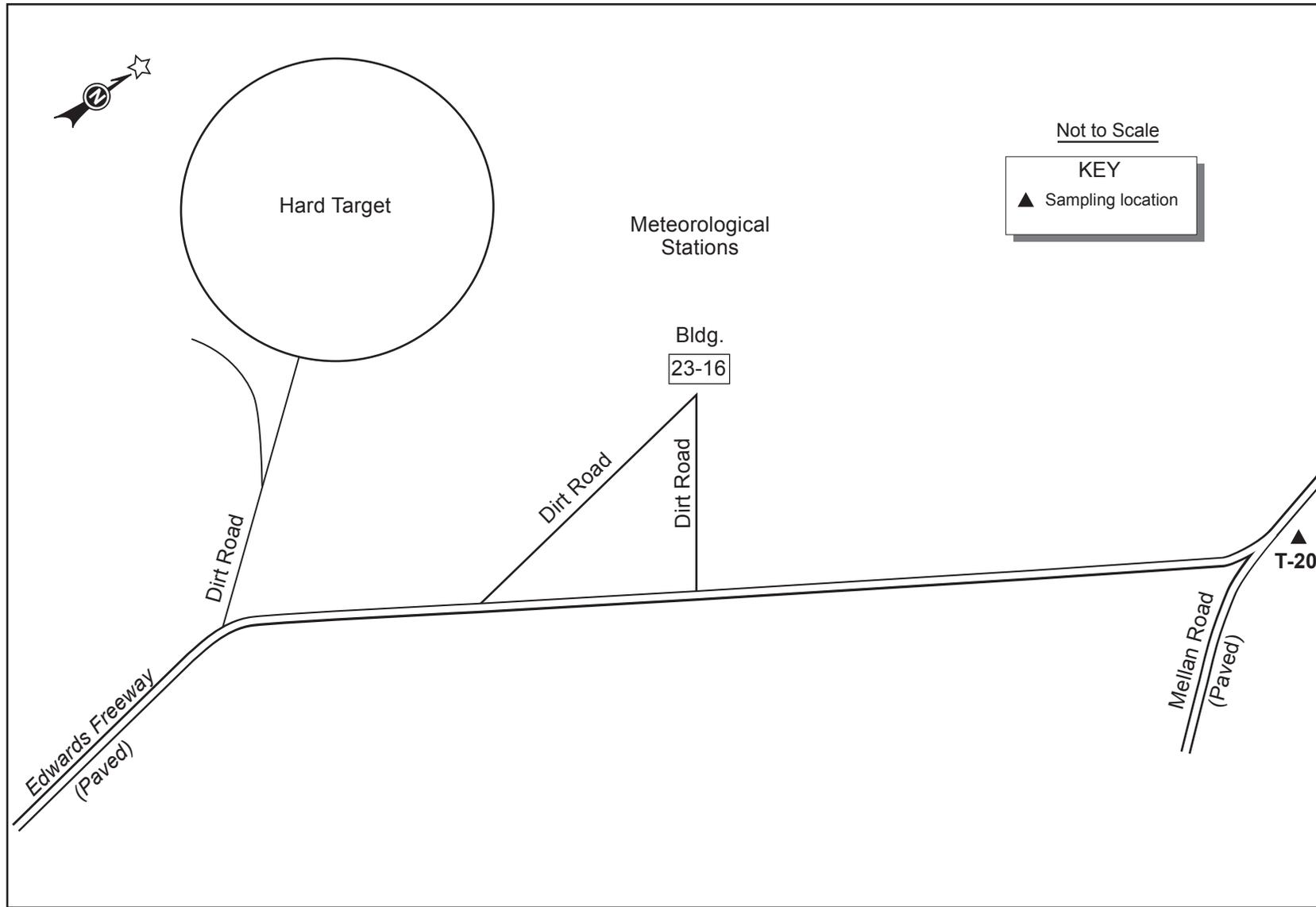
Analyte	Units	MDL	D-01	MH-03	MH-04	T-02	T-03	T-04	T-10	T-20
Aluminum	mg/kg	0.0615	8590	6030	5520	6080	5450	5410	5840	3650
Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815	0.0815
Arsenic	mg/kg	0.131	4.26	3.81	5.73	3.49	4.24	2.99	2.72	2.91
Barium	mg/kg	0.0465	125	119	143	85.8	102	101	102	165
Beryllium	mg/kg	0.0311	0.587	0.418	0.415	0.501	0.372	0.406	0.455	0.253
Cadmium	mg/kg	0.0382	0.0382	0.42	0.16	0.0382	0.0382	0.0942	0.0791	0.0818
Chromium	mg/kg	0.0645	6.02	4.34	3.55	3.66	3.73	3.39	3.73	2.18
Cobalt	mg/kg	0.0555	6.13	2.65	3.36	2.67	2.81	2.7	2.96	1.77
Copper	mg/kg	0.1	6.47	5.05	4.69	3.71	3.94	4.12	4.58	3.37
Iron	mg/kg	1.14	10900	6050	5530	5520	5930	5740	6320	4090
Lead	mg/kg	0.099	11	306	9.88	8.48	11.1	6.79	7.54	4.68
Magnesium	mg/kg	0.184	4810	2840	2680	2460	2360	2540	2930	1830
Manganese	mg/kg	0.0885	370	259	583	255	380	401	385	172
Mercury	mg/kg	0.0152	0.0106	0.0109	0.00753	0.0065	0.00809	0.00798	0.00689	0.0152
Nickel	mg/kg	0.072	5.78	4.2	3.86	4.22	3.21	3.33	3.68	1.99
Potassium	mg/kg	2.3	3280	2950	2280	2370	1920	2120	2940	1740
Selenium	mg/kg	0.146	0.146	0.329	0.146	0.146	0.146	0.296	0.146	0.146
Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205
Vanadium	mg/kg	0.074	15.6	9.73	9.69	9.32	11.4	9.87	10.2	6.88
Zinc	mg/kg	0.138	37.7	170	24.7	24.2	22.7	23.6	25.1	14.5

NOTE: mg/kg = milligram per kilogram



00_B-5b.ai

FIGURE B-5b. Various Soil Sampling Locations at Mellan Hill Area
(Two Locations)



00_B-5c.ai

FIGURE B-5c. Various Soil Sampling Locations Near the Hard Target/Depleted Uranium Area (Two Locations)

TABLE B-6a. Radiological Replicate Sampling for Soil Sampling Locations, 2000

Location Type	Location	Analyte	Units	Sample ID	Result	Error	MDA	Average	Std Dev	Min	Max	CV%
Various On-site	D-01	Americium-241	pCi/g	050954-01	3.58	0.66	0.0274	1.95	1.47	0.732	3.58	75.44%
				050954-02	0.732	0.241	0.0347	--	--	--	--	--
				050954-03	1.53	0.288	0.0311	--	--	--	--	--
		Cesium-137	pCi/g	050954-01	0.1	0.062	0.00951	0.10	0.04	0.0542	0.133	41.34%
				050954-02	0.0542	0.0496	0.0103	--	--	--	--	--
				050954-03	0.133	0.0438	0.00937	--	--	--	--	--
		Potassium-40	pCi/g	050954-01	22.1	2.28	0.13	26.43	3.76	22.1	28.9	14.24%
				050954-02	28.3	3.03	0.143	--	--	--	--	--
				050954-03	28.9	2.97	0.129	--	--	--	--	--
		Uranium	mg/kg	050954-01	0.543	--	0.0018	0.73	0.26	0.543	1.03	35.59%
				050954-02	1.03	--	0.0018	--	--	--	--	--
				050954-03	0.625	--	0.0018	--	--	--	--	--
Various On-site	T-03	Americium-241	pCi/g	050957-01	-0.0282	0.102	0.0296	0.11	0.12	-0.0282	0.218	116.49%
				050957-02	0.218	0.211	0.0372	--	--	--	--	--
				050957-03	0.132	0.201	0.0417	--	--	--	--	--
		Cesium-137	pCi/g	050957-01	0.358	0.0717	0.00874	0.39	0.03	0.358	0.418	7.73%
				050957-02	0.418	0.065	0.00908	--	--	--	--	--
				050957-03	0.388	0.0741	0.0102	--	--	--	--	--
		Potassium-40	pCi/g	050957-01	30.7	3.27	0.121	32.73	1.77	30.7	33.9	5.40%
				050957-02	33.9	3.74	0.127	--	--	--	--	--
				050957-03	33.6	3.91	0.142	--	--	--	--	--
		Uranium	mg/kg	050957-01	0.687	--	0.0018	0.61	0.07	0.564	0.687	11.09%
				050957-02	0.564	--	0.0018	--	--	--	--	--
				050957-03	0.577	--	0.0018	--	--	--	--	--

NOTE: MDA = minimal detectable activity
 CV = coefficient of variance
 Std Dev = Standard Deviation
 pCi/g = picocuries per gram
 mg/kg = millograms per kilogram

TABLE B-6a. Radiological Replicate Sampling for Soil Sampling Locations, 2000 (concluded)

Location Type	Location	Analyte	Units	Sample ID	Result	Error	MDA	Average	Std Dev	Min	Max	CV%
South Plume Area	T-14	Americium-241	pCi/g	050963-01	0.109	0.115	0.0259	0.08	0.03	0.0409	0.109	44.38%
				050963-02	0.0818	0.1	0.0292	--	--	--	--	--
				050963-03	0.0409	0.0768	0.0266	--	--	--	--	--
		Cesium-137	pCi/g	050963-01	0.596	0.0881	0.00734	0.57	0.04	0.52	0.596	7.56%
				050963-02	0.52	0.0731	0.00749	--	--	--	--	--
				050963-03	0.593	0.0739	0.00784	--	--	--	--	--
		Potassium-40	pCi/g	050963-01	33.5	3.4	0.102	32.20	1.15	31.3	33.5	3.58%
				050963-02	31.3	3.16	0.101	--	--	--	--	--
				050963-03	31.8	3.51	0.106	--	--	--	--	--
	Uranium	mg/kg	050963-01	0.426	--	0.0018	0.46	0.03	0.426	0.483	6.88%	
			050963-02	0.479	--	0.0018	--	--	--	--	--	
			050963-03	0.483	--	0.0018	--	--	--	--	--	

NOTE: MDA = minimal detectable activity
 CV = coefficient of variance
 Std Dev = Standard Deviation
 pCi/g = picocuries per gram
 mg/kg = millograms per kilogram

TABLE B-6b. Stable Metal Replicate Sampling for Soil Sampling Locations, 2000

Location Type	Location	Sample ID	Analyte	Units	MDL	Replicate			Average	Std Dev	Min	Max	CV%
						01	02	03					
Various On-site	D-01	050954	Aluminum	mg/kg	0.615	8590	7980	10200	8923	1147	7980	10200	12.85%
			Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.0815	0	0.0815	0.0815	0.00%
			Arsenic	mg/kg	0.131	4.26	3.65	4.63	4.18	0.49	3.65	4.63	11.84%
			Barium	mg/kg	0.0465	125	124	131	127	4	124	131	2.99%
			Beryllium	mg/kg	0.0311	0.587	0.527	0.737	0.617	0.108	0.527	0.737	17.53%
			Cadmium	mg/kg	0.0382	0.0382	0.0382	0.0382	0.0382	0	0.0382	0.0382	0.00%
			Chromium	mg/kg	0.0645	6.02	6.77	7.41	6.73	0.70	6.02	7.41	10.33%
			Cobalt	mg/kg	0.0555	6.13	6.77	6.85	6.58	0.39	6.13	6.85	5.99%
			Copper	mg/kg	0.1	6.47	5.74	7.77	6.66	1.03	5.74	7.77	15.44%
			Iron	mg/kg	1.14	10900	11400	14300	12200	1836	10900	14300	15.05%
			Lead	mg/kg	0.099	11	9.67	13.8	11.49	2.11	9.67	13.8	18.35%
			Magnesium	mg/kg	0.184	4810	5040	5630	5160	423	4810	5630	8.20%
			Manganese	mg/kg	0.0885	370	418	407	398	25	370	418	6.31%
			Mercury	mg/kg	0.0152	0.0106	0.00959	0.014	0.011	0.002	0.00959	0.014	20.27%
			Nickel	mg/kg	0.072	5.78	5.87	6.86	6.17	0.60	5.78	6.86	9.71%
			Potassium	mg/kg	2.3	3280	2970	4000	3417	528	2970	4000	15.47%
			Selenium	mg/kg	0.146	0.146	0.146	0.47	0.254	0.187	0.146	0.47	73.65%
			Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0	0.101	0.101	0.00%
Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0	0.205	0.205	0.00%			
Vanadium	mg/kg	0.074	15.6	14.9	19	16.5	2.2	14.9	19	13.29%			
Zinc	mg/kg	0.138	37.7	37.5	42	39.1	2.5	37.5	42	6.51%			

NOTE: MDL = minimum detection limit
 CV = coefficient of variance
 Std Dev = Standard Deviation
 mg/kg = milligrams per kilogram

TABLE B-6b. Stable Metal Replicate Sampling for Soil Sampling Locations, 2000 (continued)

Location Type	Location	Sample ID	Analyte	Units	MDL	Replicate			Average	Std Dev	Min	Max	CV%
						01	02	03					
Various On-site	T-03	050957	Aluminum	mg/kg	0.615	5450	4740	5640	5277	474	4740	5640	8.99%
			Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.0815	0	0.0815	0.0815	0.00%
			Arsenic	mg/kg	0.131	4.24	5.37	3.59	4.40	0.90	3.59	5.37	20.47%
			Barium	mg/kg	0.0465	102	86.5	91.3	93.3	7.9	86.5	102	8.51%
			Beryllium	mg/kg	0.0311	0.372	0.334	0.396	0.367	0.031	0.334	0.396	8.51%
			Cadmium	mg/kg	0.0382	0.0382	0.0382	0.0814	0.0526	0.0249	0.0382	0.0814	47.42%
			Chromium	mg/kg	0.0645	3.73	2.97	3.74	3.48	0.44	2.97	3.74	12.69%
			Cobalt	mg/kg	0.0555	2.81	2.48	2.84	2.71	0.20	2.48	2.84	7.37%
			Copper	mg/kg	0.1	3.94	3.54	4.29	3.92	0.38	3.54	4.29	9.57%
			Iron	mg/kg	1.14	5930	4970	5630	5510	491	4970	5930	8.91%
			Lead	mg/kg	0.099	11.1	8.44	8.5	9.35	1.52	8.44	11.1	16.25%
			Magnesium	mg/kg	0.184	2360	2010	2570	2313	283	2010	2570	12.23%
			Manganese	mg/kg	0.0885	380	313	316	336	38	313	380	11.25%
			Mercury	mg/kg	0.0152	0.00809	0.00898	0.00907	0.00871	0.00054	0.00809	0.00907	6.22%
			Nickel	mg/kg	0.072	3.21	3.74	3.63	3.53	0.28	3.21	3.74	7.93%
			Potassium	mg/kg	2.3	1920	1930	2110	1987	107	1920	2110	5.38%
			Selenium	mg/kg	0.146	0.146	0.146	0.146	0.146	0	0.146	0.146	0.00%
			Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0	0.101	0.101	0.00%
			Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0	0.205	0.205	0.00%
Vanadium	mg/kg	0.074	11.4	8.1	9.62	9.7	1.7	8.1	11.4	17.02%			
Zinc	mg/kg	0.138	22.7	19.3	22.6	21.5	1.9	19.3	22.7	8.98%			

NOTE: MDL = minimum detection limit
 CV = coefficient of variance
 Std Dev = Standard Deviation
 mg/kg = milligrams per kilogram

TABLE B-6b. Stable Metal Replicate Sampling for Soil Sampling Locations, 2000 (*concluded*)

Location Type	Location	Sample ID	Analyte	Units	MDL	Replicate			Average	Std Dev	Min	Max	CV%
						01	02	03					
South Plume Area	T-14	050963	Aluminum	mg/kg	0.615	7820	8070	7160	7683	470	7160	8070	6.12%
			Antimony	mg/kg	0.0815	0.0815	0.0815	0.0815	0.0815	0	0.0815	0.0815	0.00%
			Arsenic	mg/kg	0.131	2.53	2.78	2.37	2.56	0.21	2.37	2.78	8.07%
			Barium	mg/kg	0.0465	226	223	215	221	6	215	226	2.57%
			Beryllium	mg/kg	0.0311	0.41	0.439	0.389	0.41	0.03	0.389	0.439	6.08%
			Cadmium	mg/kg	0.0382	0.145	0.25	0.217	0.20	0.05	0.145	0.25	26.32%
			Chromium	mg/kg	0.0645	4.46	4.42	3.76	4.21	0.39	3.76	4.46	9.33%
			Cobalt	mg/kg	0.0555	3.53	3.67	3.15	3.45	0.27	3.15	3.67	7.80%
			Copper	mg/kg	0.1	5.71	5.55	5.1	5.45	0.32	5.1	5.71	5.80%
			Iron	mg/kg	1.14	6610	7610	6390	6870	650	6390	7610	9.46%
			Lead	mg/kg	0.099	11.6	11.8	9.62	11.0	1.2	9.62	11.8	10.95%
			Magnesium	mg/kg	0.184	3270	3700	3130	3367	297	3130	3700	8.82%
			Manganese	mg/kg	0.0885	512	441	385	446	64	385	512	14.27%
			Mercury	mg/kg	0.0152	0.0085	0.0104	0.0155	0.0115	0.0036	0.0085	0.0155	31.57%
			Nickel	mg/kg	0.072	4.71	4.7	4.02	4.5	0.4	4.02	4.71	8.84%
			Potassium	mg/kg	2.3	3830	4330	4330	4163	289	3830	4330	6.93%
			Selenium	mg/kg	0.146	0.297	0.146	0.146	0.196	0.087	0.146	0.297	44.40%
			Silver	mg/kg	0.101	0.101	0.101	0.101	0.101	0	0.101	0.101	0.00%
			Thallium	mg/kg	0.205	0.205	0.205	0.205	0.205	0	0.205	0.205	0.00%
Vanadium	mg/kg	0.074	14.1	13.1	13.4	13.5	0.5	13.1	14.1	3.79%			
Zinc	mg/kg	0.138	27.4	27.6	24.2	26.4	1.9	24.2	27.6	7.23%			

NOTE: MDL = minimum detection limit
 CV = coefficient of variance
 Std Dev = Standard Deviation
 mg/kg = milligrams per kilogram

TABLE B-7. Summary TLD Results for 2000, Tonopah Test Range

Location Type	Units	No. Locations	Total Exposure	Std Dev	Minimum	Maximum	# Days
Off-site	mR	5	147.0	9.3	136.6	161.9	381
Perimeter	mR	4	131.4	22.1	100	151	381
On-site	mR	13	142.8	10.6	125.4	169.3	381

NOTE: mR = milliroentgen
Std Dev = standard deviation

TABLE B-8. TLD Measurements by Quarter and Location Type, Tonopah Test Range

Location Class	Loc	Units	1 st Quarter			2 nd Quarter			3 rd Quarter			4 th Quarter			Yearly		
			Exposure	Error	Days	Exposure	Error	Days									
Community	T-18	mR	40.9	2.6	91	39.5	1.4	110	42.9	1.9	92	38.6	1.3	88	161.9	3.7	381
	T-19	mR	38.3	2.8	91	28.9	1.8	110	28.9	2.2	92	38.6	1.7	88	144.7	4.3	381
	T-20	mR	40.6	2.3	91	34.0	0.9	110	32.0	1.6	92	37.2	0.8	88	143.8	3.0	381
	T-21	mR	37.4	2.5	91	34.5	1.3	110	29.2	1.8	92	35.5	1.2	88	136.6	3.6	381
	T-22	mR	40.3	3.4	91	36.9	2.6	110	32.5	2.9	92	38.1	2.6	88	147.8	5.8	381
Averages			39.5	2.7	91	36.8	1.6	110	33.1	2.1	92	37.6	1.5	88	147.0	4.1	381

Location Class	Loc	Units	1 st Quarter			2 nd Quarter			3 rd Quarter			4 th Quarter			Yearly		
			Exposure	Error	Days	Exposure	Error	Days									
Perimeter	T-06	mR	20.9	2.4	91	26.7	1.2	110	24.1	1.7	92	28.3	1.1	88	100.0	3.4	381
	T-08	mR	37.7	2.9	91	34.7	2.0	110	32.2	2.3	92	36.3	1.9	88	140.9	4.6	381
	T-11	mR	41.9	2.9	91	40.0	2.0	110	29.6	2.4	92	39.5	2.0	88	151.0	4.7	381
	T-12	mR	24.0	2.4	91	39.8	1.0	110	28.9	1.6	92	40.9	0.9	88	133.6	3.2	381
Averages			31.1	2.6	91	35.3	1.6	110	28.7	2.0	92	36.3	1.5	88	138.4	4.0	381

Location Class	Loc	Units	1 st Quarter			2 nd Quarter			3 rd Quarter			4 th Quarter			Yearly		
			Exposure	Error	Days	Exposure	Error	Days									
On-site	T-01	mR	47.3	2.4	91	46.1	1.0	110	32.8	1.6	92	43.1	0.9	88	169.3	3.2	381
	T-02	mR	41.3	2.8	91	41.3	1.8	110	29.3	2.2	92	39.8	1.7	88	151.7	4.3	381
	T-03	mR	39.8	2.4	91	37.0	1.1	110	31.8	1.7	92	38.5	1.0	88	147.1	3.3	381
	T-04	mR	39.1	2.6	91	36.5	1.4	110	31.2	1.9	92	37.5	1.4	88	144.3	3.8	381
	T-05	mR	36.3	2.7	91	33.5	1.7	110	36.1	2.1	92	33.1	1.6	88	139.0	4.1	381
	T-07	mR	34.3	2.3	91	31.9	0.9	110	26.4	1.6	92	32.8	0.8	88	125.4	3.0	381
	T-09	mR	38.4	2.3	91	33.4	0.9	110	29.0	1.6	92	34.4	0.8	88	135.2	3.0	381
	T-10	mR	39.2	2.5	91	39.1	1.3	110	28.8	1.8	92	36.6	1.2	88	143.7	3.6	381
	T-13	mR	39.6	3.3	91	39.6	2.5	110	30.0	2.9	92	36.2	2.5	88	145.4	5.6	381
	T-14	mR	40.1	2.3	91	39.2	0.8	110	28.6	1.5	92	35.9	0.7	88	143.8	2.9	381
	T-15	mR	36.5	2.4	91	33.2	1.2	110	30.0	1.8	92	32.7	1.1	88	132.4	3.4	381
	T-16	mR	46.2	2.4	91	33.4	1.0	110	29.2	1.6	92	34.3	0.9	88	143.1	3.2	381
T-17	mR	36.6	2.6	91	33.3	1.4	110	31.5	1.9	92	34.2	1.4	88	135.6	3.8	381	
Averages			39.6	2.5	91	36.7	1.3	110	30.4	1.9	92	36.1	1.2	88	142.8	3.6	381

NOTE: mR = milliroetgen

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